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THE NATURE CONSERVANCY

WHEN attention was directed to the work of the Nature Conservancy in an adjournment debate in the House of Commons on October 22, the two principal points stressed were the importance for the work of the Conservancy of both adequate finance and of public understanding. Those are likewise the two major points emphasized in the report of the Conservancy for the year ended September 30, 1954*, apart from the summary of the revised scientific programme of the Conservancy. During the past year, most of the remaining major gaps in the first stage of building up its organization and working arrangements have been filled; and for England and Wales the initial reconnaissance and listing of sites of special scientific interest have been finished, though the greater part of Scotland remains to be tackled, with the exception of the Central Lowland countries, where most threats to sites of this character arise. The Conservancy's two research stations and its two field stations were manned, fitted out and in almost full operation in time for the spring and summer field-work programme of 1954, while with the removal to the new London headquarters in Belgrave Square the important supporting services, notably the library and those for documentation, maps and photographs, came into fuller operation.

Owing to the long-term nature of the Conservancy's research work, the full results of these developments will not be felt for some years; but meanwhile administrative reorganization has permitted extensive decentralization, considerable progress has been made in identifying recurrent problems and in formulating appropriate procedures and policies to facilitate quick decisions, and the rate of declaration of national nature reserves, though still too slow, has improved. During the year, the number rose from 11 to 12, the acreage increasing from 22,497 to 71,152, chiefly through the 39,689 acres of the Cairngorm Reserve declared in July 1954. The entire programme of proposed nature reserves and the arrangements for dealing with them are at present under critical and detailed review by the Nature Conservancy.

Already in last year's annual report the Conservancy suggested that finance had become the main limiting factor in its activities. We are now told that, owing to financial stringency, works for the safeguarding and maintenance of existing nature reserves in Britain have had to be cut far below a reasonable minimum, and that in the current financial year severe economy will have to be exercised in respect of all the Conservancy's activities to keep within a financial provision which, in the debate on October 22, Mr. J. R. Bevins put at about £200,000. In the year ended March 31, 1954, actual expenditure, according to the present report, was £131,602 against a grant-in-aid of £125,000, and capital expenditure £34,038 against a grant-in-aid of £15,000, the difference being covered by a balance of £24,686 carried

* Report of the Nature Conservancy for the year ended 30th September, 1954. Pp. iv+55+4 plates. (London: H.M. Stationery Office, 1954.) 3s. net.

over from the previous capital account. For the six months ended September 30, 1954, expenditure was running close to estimate, and the Conservancy emphasizes that this situation affects the transport and supply of equipment and stores for its research stations and restricts well below the desirable level the award of postgraduate studentships and of grants for scientific work. It also embarrasses land management by compelling the Conservancy to postpone the fencing of reserves and long overdue woodland operations.

The Nature Conservancy is emphatic on the seriousness and urgency of the financial situation. The consequences are fairly and clearly stated, and the argument is the more impressive for the moderation and restraint with which it is advanced. There is no attempt to ignore the stringency of the national economic position or the possibility that conditions at present may not allow the present budget of the Conservancy to be increased; equally, the nation is left in no doubt as to the seriousness of the consequences that may then ensue.

Those consequences in two respects are parallel with those which followed the present Government's, and its predecessor's, parsimony towards the National Parks Commission. First, the acquisition of reserves will be so retarded that a number of irreplaceable sites of the greatest national scientific importance will be irretrievably lost. Moreover, the maintenance and bringing into good order of existing reserves will also be crippled, so that deterioration, both scientific and economic, cannot be avoided. Secondly, the advisory and educational work of the Conservancy, which could be of great value to farmers and foresters, sporting interests, schools and universities, will have to be curtailed or postponed indefinitely.

The importance of both the acquisition of reserves and their educational function, which like the financial situation in general was emphasized in the debate in the House of Commons on October 22, can only be fully appreciated against the context of the general situation in Britain in regard to the use of land. With the increase in population and of production, of mobility and of the claims of defence, the pressure on hitherto untouched land, which was already acute during the War, is becoming even greater. Probably few appreciate the extraordinary number of conflicting claims on individual sites, the amount of man-power used by both central and local authorities in examining and deciding on such claims, and the consequences of the Government's sustained refusal to ensure that Departments are not allowed to be the sole judges of their own causes. The Conservancy testifies to the immense amount of helpfulness and fairmindedness encountered among those concerned with the reconciliation of conflicts of interest over the use of land; but the very admission that there is no simple way of reconciling such conflicts enhances the need for clear and widespread public understanding of the purposes and functions both of the National Parks Commission and of the Nature Conservancy.

But there is a further reason why such educational work should be vigorously carried out by the Nature Conservancy, and one of particular interest to the scientific worker. The function of the Nature Conservancy is not primarily that of conservation or preservation. It is a research or experimental organization of the first importance, and its expenditure should be reviewed as part of, and alongside, the national expenditure on scientific research as a whole. Even its educational work has also an important scientific bearing. One consequence of inability of the Conservancy to employ a sufficient proportion of young scientists who have been trained and to provide them with the necessary technical assistance, equipment and transport to the isolated field sites where much of their work has to be done is, as the report notes, loss of the full fruits of the long-term postgraduate training policy already initiated, and under which ten studentships were awarded during the year and thirty-four were currently in force.

Here again the lower number of awards is attributed to financial stringency and to the rising cost per student. It is the more appropriate, accordingly, that the Conservancy should report direct to the Lord President of the Council irrespective of his membership, *ex-officio*, of the Committee of the Privy Council for Agricultural Research and Nature Conservation. The Conservancy has done well also to include in the present report a summary of the revised scientific programme which has resulted from a thorough review of all existing and proposed research projects, with the object of concentrating effort where it promises the best results, having in mind the scarcity of resources. As a direct outcome of this, the report presents a concise picture of the Conservancy's actual and potential contribution to ecological research which is admirably designed to enlist the understanding and support of scientists generally, whether they are themselves engaged in such work or in related fields or not.

The survey work of the Conservancy aims at acquiring knowledge about every site of scientific interest in Great Britain, a good deal more about sites selected as of major importance (including national nature reserves) and a vast amount on a limited number of sites specially adapted for research. For every nature reserve a reserve record is kept, containing large-scale maps, air and ground photographs at different dates, species lists and censuses, ecological surveys, climatic observations, soil and geological data, historical records, accounts of management operations, and, for all woodland reserves, a vegetation survey and a sylvicultural plan. The work of the Conservancy's scientists is concentrated on reserves or other specially selected sites on which survey is complementary to a programme of research. A more extensive survey programme in Scotland, which is mapping the distribution of the remaining native woodland, will provide a clearer picture of the woodland cover of Scotland, most of which was destroyed by felling and burning; and the Conservancy's research on Scottish mountain vegetation seeks to analyse and describe important areas in greater detail than hitherto attempted and to investigate the effects of such factors as sheep-grazing and snow cover on the

distribution and composition of the plant communities. In the south of England a survey across Kingley Vale and Old Winchester Hill Nature Reserves and the proposed nature reserve at Lullington Heath is designed to afford valuable information both on the relations of the vegetation to soil, slope and exposure and on the changes, already noticeable at Lullington Heath, which may ensue when rabbit populations have been greatly reduced by myxomatosis.

To facilitate the availability of results so collected, the Conservancy is also studying appropriate systems of documentation, and has assisted the Botanical Society of the British Isles in compiling an atlas of plant distribution. Close touch is maintained with other ecological research proceeding at the universities, in independent institutions or under official organizations, and the possibility of overlapping is kept constantly in mind. Reference was made in the House of Commons debate to the investigations on myxomatosis and the effect of using chemical spraying for the control of weeds in roadside verges and hedgerows, and to the work on the technique of stabilizing shifting coastlines by means of appropriate vegetation which the Conservancy has resumed at Bridgwater Bay. Like the study of the vole plague in the Forestry Commission's plantations in the Carron Valley, Stirlingshire, or that on the ecology of high-level grasslands with special reference to the grazing factor now being initiated on the Moor House Reserve, these investigations represent as yet a comparatively slight proportion of the Conservancy's scientific effort compared with that expended on the study of woodlands.

That study was the earliest line of research to be developed by the Conservancy. Carried on with the co-operation of the Forestry Commission and largely on Forestry Commission land, it has involved detailed study of soil conditions in relation to a wide variety of species of trees. It has provided a sound basis for assessing the biological productivity of different types of woodland, and has opened up, for example, possibilities of comparing reliably the sustained yield capacity of a given site under different types of afforestation and under different types of cultivation or livestock rearing. The scientific investigations have now been extended to the district around Merlewood, as well as Gisburn Forest, Ennerdale, Roudsea Wood and Witherslack Wood, and Thetford Chase. Studies of soil conservation and afforestation have been extended to peat soils in North Wales and to a Cotswold locality on the Great Oolite, while on the Beinn Eighe Reserve experimental research on the restocking and extension of the wood by natural vegetation includes also the collection of data on the possible structure and dynamics of natural pine forest under Scottish conditions and fundamental studies on the autoecology of the pine.

The bearing of this extensive programme on Britain's economy is obvious; but the Conservancy also points out that in dealing with woodlands no hard-and-fast line can be drawn between survey, research and scientific management. Conservation may involve anything between leaving an untouched wilderness alone and carrying out a comprehensive programme of cautious and flexible modifications of the conditions produced by human interference. In all the Conservancy's woodlands, the first step is reconnaissance and primary survey, followed by the drawing up of a scientific basis of management and by more intensive survey and experimental work. Moreover, at Merlewood a distinct but related line of attack aims at describing the soil fauna associations in different types of local woodlands and studying the role of this fauna in the breakdown of litter and in its incorporation into the forest soils.

Perhaps the most impressive feature of the whole report is not so much the economic and scientific importance of the varied work which is already being carried out by the Conservancy, but the extent of the effort that has been possible within the slender resources available to the Conservancy. Even in the present financial stringency, it seems clear that the nation cannot afford to curtail the activities of the Conservancy, or to incur the risks which are involved if the Conservancy is unable to accelerate its acquisition of reserves and to extend its scientific work. But the question as to the proper financial appropriation for the work of the Conservancy should be considered not in isolation but in the context of the national expenditure on scientific and industrial research as a whole. In relation to an expenditure on civil research, estimated by Mr. J. R. Bevins as of the order of £20 million, an expenditure of £200,000 seems small enough, apart from the important returns in forestry and in agriculture alone which it is already yielding.

The point is one to which the attention of the Advisory Council for Scientific Policy might well be directed, and it should not escape that of the Parliamentary and Scientific Committee. There is a further reason for hoping that the debate on October 22 will stimulate that Committee to take up some of the points raised by the present report of the Nature Conservancy. The potential value of its scientific, educational and other activities is as yet understood and accepted only by an informed minority; yet the effectiveness of some of those activities depends largely on co-operation by local authorities and other bodies as well as by private individuals. There is need, as the Conservancy recognizes, not only to demonstrate this value by tangible results, but also to bring it home to wider circles by effective publicity.

Some of this educational work and publicity is being undertaken by the Conservancy itself, but it is limited by the slender financial resources. It needs to be supplemented by much voluntary work, and the present report supplies material which the scientist could easily use to extend the general understanding of the work of the Conservancy and its national importance. Here in particular the Parliamentary and Scientific Committee could render powerful support, and especially by promoting the fuller and clearer understanding by Parliament of the economic and scientific importance of the work of the Conservancy.

RATIONALISM AS A CREED

Human Society in Ethics and Politics

By Bertrand Russell. Pp. 240. (London: George Allen and Unwin, Ltd., 1954.) 15*s*. net.

WE are told on the dust jacket of this book that, as Bertrand Russell fully subscribes to Hume's view that "Reason is and ought only to be the slave of the passions", it is unfair to criticize him, as many have done, on the ground that he over-estimates the part which reason is capable of playing in human affairs. The present book certainly affords evidence on which the first part of this statement can be based; but we are left in doubt after we have read it whether Russell has worked out for himself a new view of the relation between reason and emotion, or whether he is merely a somewhat repentant rationalist undergoing an attack of second thoughts.

The starting-point of his ethical argument is the assumption that it "differs from scientific argument in being addressed to the emotions" and that the basis of ethics is "emotion and feeling". But this is the last concession that Russell makes to his critics, for he seems to be unable to explain how it is that man is guided by his feelings to distinguish the good from the bad, and assume an obligation to do right rather than wrong. One might suppose from what he says in his more cynical or depressed moments that man's instincts lead him to a course of action in the opposite direction. "There is no limit", he says, "to the horrors that can be inflicted by a combination of scientific intelligence with the malevolence of Satan. . . . Human imagination long ago pictured Hell, but it is only through recent skill that men have been able to give reality to what they imagined. . . ."

It is true that Bertrand Russell concludes that "the bright vault of Heaven" and the "dark pit of Hell" are equally "natural" to the human mind. But he has little to say on the question why it may be hoped that man will seek one and avoid the other. Religious instruction is rejected by him as it fosters "dogmatic beliefs", in the decay of which he can see "nothing but good". "What the world needs", he says, "is not dogma, but an attitude of scientific enquiry, combined with a belief that the torture of millions is not desirable, whether inflicted by Stalin or by a Deity imagined in the likeness of the believer".

To find a source for true belief of this kind, Russell is thrown back on reason once more, despite all his protestations that it is "not a cause of action, but a regulator". The only thing he can find to "redeem mankind" is "co-operation", the first step towards which "lies in the hearts of individuals". It is usual to wish oneself well, but "wishing well to oneself", he argues, "is sure to be futile unless it is combined with wishing well to others", and it is therefore evident to him that this should be made the basis of practical politics. The unhappy truth is, however, that arguments of this kind have not appealed to many of the more destructive politicians of our times, and it is this central problem which Russell has left unsolved.

However, he goes on to claim, it will pay us to be good, in the long run. "It is obvious to every person capable of free scientific enquiry that the doctrines of Lysenko are less likely to increase the wheat supply of Russia than those of orthodox geneticists are to increase the supply of the West. I think it is also very doubtful whether nuclear research can long continue to flourish in such an atmosphere as Stalin produced in Russia." Or, as Gibbon put it, the "gradual advance (of barbarians) in the science of war would always be accompanied, as we may learn from the example of Russia, with a proportionate improvement in the arts of peace and civil policy, and they themselves must deserve a place among the polished nations whom they subdue". Thus do the minds of great rationalists think alike.

It is not, however, on grounds of logical inconsistency that Bertrand Russell's work is most open to criticism. The plain fact is that the rationalism on which it rests does not attract the minds of more than a handful of the young men and women in our universities to-day, who are faced with the responsibility of deciding the critical issues of their lives in the years that lie immediately ahead. Rationalism is a dead creed for them, despite current attempts to accept emotion as well as reason as a significant influence in our lives. It has not yet been replaced in the Western world by anything that stands the tests of criticism and experience, and the younger generation of thinkers must be regarded as facing the intimidating task of discovering a new philosophy and a new faith, or rediscovering an old one.

T. S. Simey

NUCLEAR SCIENCE IN PHYSICS, CHEMISTRY AND BIOLOGY

Annual Review of Nuclear Science

Edited by James G. Beckerley. Vol. 3, 1953. Pp. x+412. (Stanford, Calif.: Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences, 1953.) 7 dollars.

THIS third volume of "Annual Reviews of Nuclear Science" is the first one for which the editors and the editorial committee of the Annual Reviews, Inc., Stanford, California, are fully responsible. Its policy is evident by the wide field of subjects covered, ranging from reactions of π-mesons with nucleons to vertebrate radiobiology, histopathology and carcinogenesis. Of 392 pages, about 190 are devoted to physics, 80 to chemistry and 120 to biological subjects. The laudable aim as expressed by the editors is to give the 'nuclear scientist' a chance to keep up with the whole field provided he knows the 'fundamentals'. But how does the harassed physicist find time and energy to read it all when the flood of information in his own specialized field is getting larger and less manageable every day? In addition, there are more reviews being published by the American Physical Society, the Physical Society (of Great Britain), "Progress in Nuclear Physics", etc.: these are summaries which the physicist can scarcely neglect and which he may even purchase. He falls into the serious danger of having no time to think for the reading. Does he choose the "Annual Reviews of Nuclear Science" series as an additional source of information if he has to pay 7 dollars? It all depends on the quality: one well-balanced, crystal-clear survey written with didactical virtuosity will go far to convince the hesitant buyer to part with the cash. If, however, he comes across a contribution consisting only of a formidable string of succeeding abstracts of papers, he will put his money back into his pocket. It follows that the author has to have plenty of leisure to read the original publications, to digest it all—a notoriously slow process—and then to set down in good English the rectified distillate of

his mental exertions, arranged in a manner logical in its sequence and revealing in its sub-sections. An author who does all that and gets it out by the appointed date is an exception.

The present volume does not do badly in some sections. I liked the summary on reactions of π-mesons with nucleons, by E. M. Henley, M. A. Ruderman and J. Steinberger, because the theoretical formalism is lucidly exposed and the experiments chosen for discussion are relevant to our endeavour to understand nuclear forces. Mesons and heavy unstable particles in cosmic rays, by Louis Leprince-Ringuet, is clear and helpful in the maze of 'new events'. A timely and, I feel, important article on extra-nuclear interactions of electrons and gamma-rays comes from D. R. Corson and A. O. Hanson; it is satisfactory to know that all is happy in the interaction of electrons with electromagnetic fields, at least as long as one is satisfied with the degree of accuracy of experiment and theory, admittedly undesirably low in some cases. Neutron optics, by D. J. Hughes, and a good survey by A. Wattenberg on standardization of neutron measurements follow. Photographic emulsions, by Y. Goldschmidt-Clermont, and radiation dosimetry and protection, by L. D. Marinelli, complete the articles on physics, the latter containing a rather good survey and useful graphs for practical purposes. The chemical field is covered by J. L. Magee on radiation chemistry (very clear exposition), chemical effects of nuclear transformations (J. E. Willard), separation techniques used in radiochemistry (P. C. Stevenson and H. G. Hicks) and isotope effects in chemical reactions (P. E. Yankwich). The volume concludes with vertebrate radiobiology—embryology (R. Rugh) and histopathology and carcinogenesis (J. Furth and A. C. Upton); cellular radiobiology (A. H. Sparrow and J. Forro, jun.); and practical aspects of radiation injury (L. H. Hempelmann and J. G. Hoffman).

The production of the volume seems satisfactorily fast: most of the surveys of the literature were concluded during March–July 1953.

E. Bretscher

THE UBIQUITOUS ALDEHYDE

Formaldehyde

By J. Frederic Walker. Second edition. (American Chemical Society Monograph Series.) Pp. xvi+575. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 96*s*. net.

THE prodigious expansion of chemical knowledge and technology is well illustrated by the fact that it takes more than five hundred pages to present "the salient facts and theories" of the chemistry of one organic compound. Ten years only have elapsed since the first edition of "Formaldehyde" appeared, but there is every justification for bringing it up to date. During that decade, the production of formaldehyde in the United States has nearly doubled, improved methods of manufacture have been introduced, its uses have multiplied, and its chemical frontiers have been considerably extended. War-time developments fostered a marked expansion in the uses of formaldehyde, particularly noticeable being the increased volume used for chemical syntheses outside the synthetic resin industry, which is still the major consumer.

In the new edition two chapters out of twenty-one are devoted to the uses of formaldehyde, its polymers and hexamethylene tetramine; the rest deal with production, properties and chemical reactions. This allocation will please some, but disappoint others. It is very doubtful whether workers in the plastics field would agree that less than twenty pages are adequate to discuss the important role of formaldehyde in their industry. However, in defence of the author it must be pointed out that the fundamental chemical reactions on which the industry is based are very ably dealt with under the reactions of formaldehyde, and, furthermore, numerous recent reference books covering the industrial and technological aspects are available. The treatment of formaldehyde production in the opening chapter represents a very marked improvement over the somewhat paltry discussion in the original volume. The five chapters dealing with the physico-chemical properties of the monomeric aldehyde, its vapour and solutions, contain a wealth of data which will prove invaluable to chemists and chemical engineers.

A welcome addition is a section on toxic hazards and safe handling. Polymer formation, one of the most characteristic properties of formaldehyde, receives full and authoritative treatment, but it is surprising to find the term trioxymethylene, which the author admits to be an erroneous designation for paraformaldehyde, still being used synonymously on several occasions. The two chapters on the qualitative and quantitative analysis of formaldehyde, its polymers and solutions are extremely good. Although a distinct chemical entity, hexamethylenetetramine may be regarded as a special form of formaldehyde, since it behaves as formaldehyde in many of its reactions and therefore rightly deserves special mention. Its general reactions, including nitration, are reviewed, but unfortunately the reader is referred elsewhere for details of the complex and interesting chemistry associated with the war-time development of the high explosive *RDX*. A valuable addition to the new volume is a chapter on the reactions of formaldehyde with heterocyclic compounds.

The monograph is not claimed to be exhaustive, and it is not surprising, therefore, to find a few minor omissions; for example, there is no reference to the reaction of formaldehyde with chloral. What is surprising, however, is to find a major industrial use of formaldehyde for the synthesis of glycollic acid, ethylene glycol and methoxymethoxyethanol dismissed at the mere mention and with no more than a brief reference to the patent literature for details of the basic reaction with carbon monoxide. Admittedly, this is a fairly recent industrial development, but the omission is all the more remarkable because the author's own company was responsible for it and since an earlier monograph in this series (No. 114, "Glycols", 1952) gives prominence to it.

A critical selection of references is appended to each chapter, and a comprehensive index at the end. The latter is not without minor blemishes—qualitative analysis is listed for quantitative, and there are some minor lapses of nomenclature. The selection of photographs adds little to the value of the book.

Let these remarks not be construed to mean that this book has not fully maintained the very high standard we have come to expect from the American Chemical Society Monograph Series. This new edition, despite its high price, will be generally welcomed and will inspire chemists to probe still further into the almost endless ramifications of the chemistry of this ubiquitous and versatile aldehyde.

J. Idris Jones

The University of Utopia

By Robert M. Hutchins. (Charles R. Walgreen Foundation Lectures.) Pp. ix+103. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 19*s*. net.

IN this brilliant sketch of the imaginary University of Utopia, Dr. Robert M. Hutchins's avowed purpose is not so much to describe the educationa system of Utopia, of which that university forms the apex, as to depict the hazards to education in the United States and the means by which these hazards may be reduced or eliminated. Chief among them are those arising out of industrialization, specialization, philosophical diversity in relation to the formation of a community, and social and political conformity. These are discussed with wit and shrewdness in four successive chapters representing lectures delivered at the University of Chicago in the spring of 1953. He has returned to some of his criticism of the American universities in lectures on the idea of an American university delivered in Great Britain last autumn, but those lectures are likely to encourage his hearers to read this book.

Although the American university is the main target of his criticism and his fourth chapter in particular is as courageous and forthright a defence of academic freedom and responsibility as is to be found in Prof. Commager's recent book, with which it may be fittingly compared, the book abounds in common sense, in aphorisms, in hard thrusts and asides which will delight the British as much as the American reader. His characterization of the custodial system resulting from the infringement of academic independence as 'adolescent-sitting' may no more commend itself in some quarters than did a certain bishop's proposal to a Lambeth Conference to entitle a conference report on education "Childhood by Second-Childhood". The value of the book, however, does not lie in its occasional astringencies but in the clarity with which it lays bare the fundamental issues involved in deciding what are the functions of a university in the world to-day. The important questions are asked, the essential principles are stated and all concerned with the application of these principles in the expansion of university and technological education in Great Britain, or with the wider question of adult education and the defence of freedom, can read these pages with profit as well as pleasure.

R. Brightman

Physical Constants of Hydrocarbons

Vol. 5: Paraffins, Olefins, Acetylenes and other Aliphatic Hydrocarbons. (Revised Values.) By Gustav Egloff. (Monograph Series No. 78.) Pp. ix+524. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 160*s*. net.

THIS volume supplements the values for the melting points, boiling points, densities and refractive indices of paraffins, olefines, acetylenes and other aliphatic hydrocarbons which were collected in Vol. 1. Best values for the normal boiling points, densities and refractive indices of many compounds are also given. Corrections to Vol. 1 are listed with cross-references.

The general arrangement of the matter in the present volume is rather wasteful of space and is frequently not clear. For example, under melting points the symbol *a* is used approximately two hundred times and is followed by the sentence "(*a*) This constant was given as a freezing point in the literature"; if it were necessary to make this distinction, it would have been simpler to put the symbol F.p. in the table. Moreover, confusion may arise because the symbol *a* is used in the same section for other purposes; for example, on p. 10 it means "This is a calculated value", while it has other meanings on pp. 228, 262 and 270. Further, since *a* may have different meanings on the same page, it will be appreciated that there is room for improvement in the arrangement.

Some idiosyncrasies have been noted. Thus, while the formula for methane is given as CH_4, that of monodeuteromethane is given as CD. Under the heading of the boiling point of methane at 760 mm. of mercury pressure are to be found 170 entries for boiling points covering the pressure range 43,168–4·24 mm. and fourteen entries for sublimation temperatures. The majority of these boiling points are arranged in descending order of pressure, but there are just enough entries out of order to break the sequence. The data on acetylene are misleading because, although this compound does not exist as a stable liquid at 760 mm. pressure, since the triple point is at 962 mm., yet four values for the boiling point at 760 mm. are listed.

Vol. 1 was published in 1939, and it is a pity that the opportunity was not taken in the present volume to include information on properties which have since been recognized as useful in establishing the identity and purity of hydrocarbon samples, for example, infra-red spectra, Raman spectra and cryoscopic constants. However, the cost of this volume is already so high that perhaps it is as well that the book was not expanded. Nevertheless, it contains much collected data, and there is no doubt that many librarians will be pleased to have this book to add to their set in this series.

E. F. G. Herington

Paper Chromatography

By Dr. Friedrich Cramer. Second revised and enlarged edition. (Translated by Leighton Richards.) Pp. xii+124+4 plates. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1954.) 25*s*. net.

IT is to be regretted that, in presenting this second, revised and enlarged edition of his book, the author has included so much subject-matter within such a limited space. The book, which is divided into two sections, is intended to provide a laboratory manual of paper chromatography. The first section deals sketchily and somewhat inaccurately with the history and theory of paper chromatography and then goes on to give a comprehensive and well-illustrated description of the various practical techniques. The newcomer to chromatography will find this portion of the book very useful.

The second section describes the application of paper chromatography to the separation of various groups of materials. The presentation of this portion of the book is unbalanced in that some applications are described in excessive detail whereas others receive only the briefest mention. A large number of useful tables and four hundred references, however, are included. That part of the book dealing with inorganic separations is so condensed and contains so many errors that it is better ignored. The book contains an annoyingly large number of mistranslations and spelling mistakes.

R. A. Wells

MOLECULAR SPECTROSCOPY

THE ramifications of molecular spectroscopy in pure and applied physics and chemistry are now so numerous and technical progress is so rapid that frequent conferences about them are not superfluous. By any standard, the two-day meeting arranged during October 28–29 by the Hydrocarbon Research Group of the Institute of Petroleum was a success. By bringing together academic and industrial workers in Britain, and others from several European countries and the United States, a critical review of current problems was possible, and future trends in technique and theory were considered. The topics discussed ranged from the vacuum ultra-violet to the far infra-red, and although many papers were directed towards hydrocarbon chemistry, there was a balanced inclusion of results on a wider scale. So far as analytical work and structural diagnosis are concerned, it is becoming increasingly important to choose the most appropriate of the various physico-chemical methods. A similar choice may now be made between the various spectroscopic methods themselves, which are so often not alternative but supplementary to each other.

Opening the first session, E. J. Bowen (Oxford) made a critical evaluation of fluorescence measurements for industrial analysis and examination. Promising as this phenomenon might appear for the study of aromatic or heterocyclic compounds, great care is needed in its interpretation. Older data are often misleading, for few compounds fluoresce, and the fluorescence is destroyed or affected by trace compounds or other factors. Purity of a solvent, and the method of excitation and of spectral recording are important, and re-absorption of the fluorescence must be considered. There may be a gain in the analysis of oils by prior chromatography, or by low-temperature measurements in a solvent which congeals to a clear glass. Yet more information is required about such processes as 'resonance transfer' whereby one molecule transfers its energy of excitation to another trace compound and induces a fluorescence which may be entirely misleading.

G. Porter and M. W. Windsor (Cambridge) described results of another kind on the fluorescence and phosphorescence of aromatic hydrocarbons. It is known that, when suitably irradiated, as solids in glassy solvents, these substances show, in addition to the normal fluorescence which appears during illumination, a slower re-emission of radiation; the latter is composite, one part having a wave-length identical to the main fluorescence and a temperature-dependent decay, the other being a slower phosphorescence of longer wave-lengths. This phosphorescence has been interpreted in terms of a metastable triplet electronic state into which the molecules pass after initial excitation. By means of their elegant method of flash photolysis, Porter and Windsor have now obtained absorption spectra due to the transitions between the triplet levels for solutions of the hydrocarbons. Some microseconds after the flash, while enough molecules are still in the lowest triplet state, an absorption spectrum is measured, and by adjustment of the time interval the decay of the triplet level has been studied from the absorption-band intensities. From the remarkable effect of the solvent viscosity on the kinetics of the decay process, the nature of the triplet state has been examined. The results obtained by this novel technique may have an important bearing upon the photochemistry of aromatic hydrocarbons and of dyestuffs.

B. F. Dudenbostel (Standard Oil Development Co.) reviewed the present state of Raman spectroscopy. As a result of the Toronto mercury arc, the magnesium oxide reflector and more sensitive uncooled electron multiplier tubes, photoelectric recording appears to have replaced photography. Samples as small as 1 ml. can be used, but suspended dust or traces of fluorescent materials must be avoided. The main advantage of direct recording lies, of course, in the direct determination of line intensities or of integrated areas under the recorded peaks. No generalization can be made about which analytical problems will be more suited to Raman or infra-red work, but the former may find much use with aromatics, especially, perhaps, in the higher-boiling petroleum fractions and also with certain mixtures of olefins. The development of an intense monochromatic source of somewhat longer wave-length, with an appropriately sensitive detector, might extend this work considerably.

A vacuum grating spectrometer with photoelectric recording to 1700 A. was described by R. A. Burdett, L. W. Taylor and L. C. Jones (Shell Oil Co.). An E.M.I. photomultiplier with a thin (1-mm.) quartz window was used. A number of substituted benzenes, polynuclear aromatic hydrocarbons and sulphur compounds dissolved in heptane have characteristically different spectra which can be used for analysis more effectively than those in the normal ultra-violet, especially if some preliminary chromatography is carried out. It would seem that a grating is preferable to a prism in the far ultra-violet and that a better source may be obtained for the region 2100–1500 A. by excitation of xenon with a microwave discharge.

The second session dealt with infra-red technique. V. Z. Williams (Perkin-Elmer Corporation) discussed critically the instruments now available for research and for industrial analytical control. The choice between different spectrometers is now mainly governed by the nature of the problem under investigation. Single-beam instruments, with interchangeable prisms covering a wide spectral range, and a double-pass system to increase resolving power and also to eliminate false energy, have high photometric accuracy and elasticity as regards use with accessories such as the reflecting microscope or long-path absorption cells. Double-beam spectrometers, on the other hand, produce a direct spectral record and eliminate atmospheric absorption, and for routine qualitative work in organic chemistry these factors are important. Also, differential analysis using the double-beam arrangement shows much promise for analytical work. However, the flexibility of double-beam instruments is more limited and their photometric accuracy may be less. For pilot-plant or

process control, continuously operating infra-red analysers are now in use for determining common gases in fairly complex mixtures. Some incorporate a small monochromator, whereas others work by non-dispersive principles. Much attention has been given to their long-term stability under rugged conditions. Their sensitivity can be as high as 0·25 p.p.m. In Dr. Williams's view, "to some extent to-day and more certainly in three years, these instruments will have a potential for the field which will be greater than the ability of the field to utilize".

These spectrometric developments do not necessarily imply an increase in instrumental complexity. In fact, there is a trend towards simplification for much of the work. One leading factor is the replacement of prisms by cheap echelette diffraction gratings, and L. A. Sayce and A. Jackson (National Physical Laboratory) described their recent work on replication from a helical matrix cut to high accuracy using the method of the Merton nut. The chief experimental inconvenience of gratings hitherto has been the need for some fore-prism arrangement to eliminate unwanted spectral orders. This difficulty may be removed by use of filters which cut off radiation at the shorter wave-length end. Important advances have occurred here by the discovery that thin layers of silicon, germanium, lead sulphide, coated silver chloride, and other substances have fairly sharp cut-off wave-lengths. More exciting possibilities are suggested by the *F*-centre filters developed by J. Gaunt and W. G. Burns (Harwell). Pohl first showed that when crystals of alkali halides acquire a stoichiometric excess of alkali metal they become coloured as a result of trapping of electrons at vacant lattice sites. Such colour centres can be formed by photochemical, radiochemical or electrolytic methods, but more satisfactory results appear to be obtained by heating the crystals with alkali metals. The conditions of preparation and subsequent cutting and polishing still need further study, but good filters appropriate to all the usual spectral regions have been produced. Their additional value for eliminating false radiation in prism spectrometers at longer wavelengths is also important. The use of cæsium iodide as a prism material (extending to 52 μ) was described by E. K. Plyler (U.S. National Bureau of Standards), and it can be used as a thin window (2 mm.) out to 65 μ. Its dispersive characteristics from 25 μ to 35 μ are not quite so good as those of cæsium bromide. In fact, all spectral needs for a prism spectrometer in the range 2–40 μ can perhaps now be met by lithium fluoride, rock salt and cæsium bromide.

The pressed disk technique used by Stimson and by Schiedt, in which solids are suspended in sintered plates of alkali halide crystal, is improving rapidly. It reduces scatter of radiation, gives sharper absorption bands, eliminates the Christiansen effect and avoids absorption by any mulling agent. M. A. Ford, G. R. Wilkinson and W. C. Price (King's College, London) described their work on this subject and indicated factors such as particle size or sintering pressure which lead to satisfactory disk formation. Care is needed because of spurious impurity bands or possible slow chemical reactions of the solids, and, before quantitative intensity work can be regarded as reliable, further tests are required. T. S. Robinson and W. C. Price (King's College, London) also described a method for calculating the absorption spectrum of a solid from its reflexion spectrum. The computation is rather elaborate, but may be useful in those cases where the absorption of thin films is still too high, as with polytetrafluoroethylene. If polarized radiation is employed the reflectance data may also be used to determine the directions of certain bonds in a molecule with respect to the crystal axes.

Several papers dealt with the interpretation of vibrational spectra for analysis, vibrational assignment and structural diagnosis. Hitherto, infra-red analysis has usually been made on the assumption of additivity of optical densities at band peaks, using extinction coefficients defined by Beer's law. This method is in reality semi-empirical, since it assumes the use of infinitely narrow slit-widths which pass monochromatic radiation. The extinction coefficients depend markedly upon the spectrometer slit-widths unless the latter are small compared with the band half-widths, and this factor alone may account for our inability to transfer infra-red data from one instrument to another. Integrated band areas have a more absolute significance, especially if they are suitably corrected for the spectrometer characteristics so as to yield the true band intensities. The band areas can be computed in several ways, but there is still uncertainty about the exact function which reproduces the band envelopes. Quite apart from their use for analysis, however, band intensity data may lead to further refinement in structural group identification, and since the intensity is related to the variation of molecular dipole during vibration, they may also tell us something about the bond polar properties. These several aspects of work on band intensities were discussed by H. W. Thompson (Oxford) and illustrated by a collection of data so far available. The construction of simple automatic devices for the integration of band areas during spectral measurement will not be long delayed. Whether, owing to band overlap or for other reasons, the true intensities will prove more valuable than extinction coefficients determined with higher spectral resolving-power, is at present an open question.

Tables of molecular vibration frequencies of substituted benzenes, which appear to depend only upon the positions of the substituent groups and not upon their nature, have been collected together by R. R. Randle and D. H. Whiffen (Birmingham). While there may still be doubt about some of the assignments to specific normal modes, and some of the rules may fail with other substituents, these correlations will be valuable, especially in hydrocarbon chemistry. Similar data were listed by E. D. Kunst (Royal Dutch Shell, Amsterdam) for deutero-aromatics in the region 12–14 μ. H. Lüther (Technical High School, Brunswick) described spectral measurements designed to elucidate the mechanism of oxidation of hydrocarbon oils, using key bands for detection of hydroxyl, ketonic and other groups.

The comparison of vibrational spectra of molecules in different states of aggregation is now leading to important information. This was fully surveyed by N. Sheppard (Cambridge) with particular reference to measurements at low temperatures. The spectral variations observed, and their interpretation, vary according as the molecule is rigid or flexible and also depend upon the coupling of vibrations in the solid lattice. Conclusions have been drawn about the relative stability of rotational isomers and about the assignment of vibration frequencies of long-chain hydrocarbons. In solid nitric acid hydrate there is spectroscopic evidence for the occurrence of the

OH_3^+ ion. The sharpening of bands at low temperatures and other features may find application in certain analytical work; but this may involve some experimental problems, and the formation on solidification of an amorphous glass rather than a crystalline mass may be vital.

Attempts to study reaction intermediates and radicals through their spectra have not, so far, been entirely successful. D. F. Hornig (Brown University) described a new approach in which shock waves have been used to excite molecular species to a 'temperature' equivalent to that of reactions or combustion processes. The time required to induce this excitation—some microseconds—may be much less than the reaction times, and it is hoped, therefore, from spectral emission or absorption to study the subsequent kinetic behaviour of the species. Very fast photographic and photoelectric methods have been used to record spectra of certain radicals produced by passing shock waves into substances such as cyanogen halides or methyl halides, and the progress of such work should be interesting. The identification of radicals in flames by resolution of their vibrational–rotational emission bands was achieved recently by Plyler, Benedict and Silverman. G. R. Wilkinson, M. A. Ford and W. C. Price (King's College, London) have now made similar measurements on emission bands in the region 1–5·5 μ of simple molecules and radicals excited by a radio-frequency discharge in hydrogen halides, methane, water vapour and other gases. This method has definite advantages over absorption measurements in that band sequences are more fully developed, and both the rotational and vibrational constants can be measured conveniently. The results of recent absorption studies on a number of hydrocarbons using very high resolving-power were also outlined by H. W. Thompson. From all these data, more precise values are being obtained, not only for the main molecular rotational constants but also for the centrifugal stretching-coefficients and anharmonic vibration factors.

Among all the above fairly conventional themes, a new note was struck at the meeting—the study of nuclear magnetic resonance—and R. E. Richards (Oxford) illustrated its value by many examples of practical importance. The spin of a charged nucleus gives rise to a magnetic effect, and the associated magnetic vector can be oriented in different ways in an applied magnetic field. These orientations correspond to different quantized energy-levels, between which transitions can take place. For fields of 10 kilogauss the absorption frequency lies in the radio region, 'resonance' occurring between the two levels and different nuclei absorbing at characteristically different frequencies. When interaction occurs between the nuclei and their surroundings—to be exact between their respective magnetic effects—the absorption lines broaden in ways which depend upon the internuclear distances and other structural features. Thus groups such as CH_3, CH_2 or OH can be characterized. Information of the most varied kind, both qualitative and quantitative, can now be obtained, and it is certain that much will result from this new highly sensitive method.

It is clear that there is intense activity in this field. The difficult task of setting up a punched-card system for reference spectra was also discussed, and it is hoped that the committee set up several years ago in Britain to consider this matter may shortly be able to institute a scheme.

H. W. Thompson

FULMER RESEARCH INSTITUTE, STOKE POGES

OPEN DAY

An informal visit was made to the Fulmer Research Institute on November 2 by H.R.H. the Duke of Edinburgh on the occasion of an open day held to mark the opening of the new Mechanical Testing Laboratory of the Institute. After a tour of the laboratories lasting for an hour and a half, during which he pulled the first test-piece in the new 50-ton tensile-testing machine of the Laboratory, the Duke had luncheon at the Institute together with some three hundred guests representing industry and research. In his speech he said that he had always been convinced that the research business was a good investment and that he was interested to have practical proof in an establishment which, without outside support, does indeed make a profit entirely on research. After luncheon the laboratories were open to the other guests, and the scientific exhibits showed in detail some of the work of the Institute during its first seven years of existence.

Following the invention of the catalytic distillation process for refining of aluminium, Dr. P. Gross and his colleagues demonstrated similar studies applied to the extraction of titanium from impure titanium-bearing materials. Laboratory exhibits showed that titanium can be removed from an impure titanium-bearing alloy by reaction with a high-valency halide to form a halide of lower valency in the vapour phase. Disproportionation of the lower-valency halide then gives a deposit of pure metallic titanium with reformation of the higher-valency halide. In connexion with the work on the purification of both aluminium and titanium, an intensive study is in progress of the reactions which may be involved in these processes, and an important feature of the work is the determination of the heats of formation of metallic halides. The apparatus, which includes dry boxes for handling deliquescent halides and a calorimeter made in the laboratory workshops, was on view. The heat of formation of aluminium fluoride has recently been re-determined by Dr. Gross, and a new value, differing appreciably from that previously accepted, has been established and the results published. The heat of formation of titanium tetrachloride has also recently been determined, but the results obtained are at present confidential to the sponsor. Further work is in hand on the heats of formation of other halides. A recent step forward in Dr. A. H. Sully's work on chromium and its alloys has been the preparation of a ductile form of chromium. Flakes of electrodeposited chromium which are capable of being bent were on view.

In the Physics Section apparatus was set up for studying by X-ray diffraction the structure of liquid metals. This involved the use of Geiger counters in plotting the variation in intensity of X-ray diffraction from a liquid metal surface. Apparatus for measuring the vapour pressure of reactive metals such as uranium was also in operation. Many novel types of camera and a curved quartz crystal monochromator were included in the apparatus for studying the progress of precipitation hardening and the ensuing structural changes. There was an extensive exhibit of the results of such an investigation on the ageing of aluminium copper alloys.

Dr. H. K. Hardy's studies on the thermodynamics of alloy systems and the mechanism of precipitation

hardening were also demonstrated, together with the results of recent research on aluminium bronzes and on the aluminium–copper–cadmium alloys. In the Corrosion Laboratory one exhibit indicated the marked influence of directionality of structure on the corrosion and stress-corrosion behaviour of high-strength aluminium alloys. This was correlated with work on the properties of material at the flash line in aluminium alloy forgings where a very high degree of directionality has been observed.

New methods of chemical and spectrographic analysis were demonstrated in the Chemical and Spectrographic Sections. These included a combined chemical and spectrographic method for the estimation of tantalum and niobium in certain soils. Apparatus recently acquired in the experimental foundry includes a vacuum or argon melting furnace in which reactive metals such as uranium and titanium can be arc-melted on to a water-cooled copper hearth. In common with a great deal of other apparatus, this has been constructed in the laboratory workshops. Facilities for metal working included a 60-ton press for powder metallurgical and similar work, a new laboratory rolling mill, a 1-cwt. forging hammer and a small laboratory extrusion press. In connexion with an investigation on the properties of semi-conductors, a technique for melting and casting rods of pure silicon for subsequent purification by zone melting was demonstrated. An exhibit showed work in progress on the development of heat-resisting coatings, and the high-oxidation resistance of steel containing relatively small quantities of silicon and aluminium (3 per cent and 1 per cent, respectively) was demonstrated. Apparatus for the study on a pilot-plant scale of the process for catalytic distillation of aluminium was on view, together with a wide variety of furnaces for heat treatment, including those with facilities for rapid water quenching from vacuum or special atmospheres.

The new Mechanical Testing Laboratory contains a 50-ton Denison tensile compression machine and a thermostatically controlled creep-testing laboratory with seven Denison tensile creep-testing machines of conventional design and four compression-type creep machines. Machines for testing the creep of strip specimens were also in operation in the creep laboratory. Fatigue tests at both room and elevated temperature were in progress, and these included reverse bend tests on sheet specimens, rotating cantilever tests and reversed tension (Haigh) fatigue testing. An interesting exhibit in this section dealt with methods of testing and improving the resistance of aluminium and its alloys to fretting and blackening by abrasion. Work in collaboration with the Department of Colloid Chemistry at the University of Cambridge under the direction of Dr. J. H. Schulman has shown that friction between aluminium surfaces can be markedly reduced by the application of substances forming so-called 'penetrated' monomolecular layers.

The activities of the Institute were described in a booklet which shows that, since 1952, thirty-eight papers from the Institute have been published, or are about to be published, by scientific societies. In the library of the Institute it was shown that, while the research reports of the Institute are confidential to sponsors, a large number of reprints of published papers are available, and a particular feature was the large number of translations, which include many scientific papers translated from the original Russian.

STRUCTURE OF VITAMIN B_{12}

A Crystalline Nucleotide-free Degradation Product of Vitamin B_{12}

IN an earlier paper[1] we have described a detailed study of the course of hydrolysis of vitamin B_{12} under both acid and alkaline conditions. It was found that under rigorous experimental conditions there were produced 1-amino-2-propanol, ammonia, 5 : 6-dimethylbenziminazole-1-α-D-ribofuranoside-2′-(or 3′)-phosphate and a deep red cobalt-containing gum which behaved as a mixture of tetra-, penta- and hexa-basic acids in the case of alkaline hydrolysis, or as a mixture of tetra-, penta-, hexa- and hepta-basic acids in the case of acid hydrolysis. The mixture of cobalt-containing acids obtained from the alkaline hydrolysis of the vitamin has now been subjected to further fractionation in order to provide material for chemical degradation and physical examination.

Vitamin B_{12} was hydrolysed with 30 per cent sodium hydroxide at 150° for 1 hr., and the tetra-, penta- and hexa-basic carboxylic acids as well as the accompanying free nucleotide were separated by electrophoresis on Whatman seed-testing paper[1,2]. Of the three coloured fractions, that corresponding to the hexabasic acid was present in the largest amount. It was converted into its ammonium salt, absorbed on a column of 'Dowex 1 *X* 2' resin (2 per cent cross-linking) and eluted with 0·6 *M* ammonium acetate solution. Several minor fractions were eluted first and were followed by the major band, which was collected separately. It was worked up in the usual way by acidification with hydrochloric acid, extraction into phenol, removal of the inorganic salts from the phenol extract by washing with dilute hydrochloric acid and then water, dilution of the phenol with ether and re-extraction of the red acid into water. After evaporation of the water, the gummy residue was dissolved in aqueous acetone and diluted with ether and kept for several weeks, when a small quantity of red prisms was obtained. This crystalline product was submitted to Dr. D. C. Hodgkin and the elegant crystallographic examination described in the following communication was carried out on one selected crystal. Further dilution of the mother liquors with ether gave fine red needles which were soluble in aqueous acetone but insoluble in either water or acetone alone. Recrystallization was wasteful but could be effected by adding ether cautiously to the aqueous acetone solution, when crystalline material was obtained from the cloudy solution after removal of some amorphous material precipitated initially. (Found on material dried to constant weight at 54°/0·05 mm. : C, 52·8 ; H, 6·3 ; N, 7·85. $C_{47}H_{66}O_{16}N_6CoCl$ requires C, 53·0 ; H, 6·25 ; N, 7·9 per cent.) An aqueous solution of the product in dilute nitric acid contained chloride ions.

The ultra-violet absorption spectrum (Figs. 1 and 2) shows a strong resemblance to that of vitamin B_{12} ; differences in the 280 mμ region are due to the absence of the 5 : 6-dimethylbenziminazole nucleotide in the hydrolysis product. In the presence of excess cyanide a bathochromic shift of the spectrum is obtained similar to that observed with vitamin B_{12} and indicates that the chromophore of the hexabasic acid is closely related to that of the parent vitamin. The infra-red spectrum, determined on a 'Nujol' mull, showed maxima at 4·67, 4·73 (weak), 5·77, 5·85, 6·01, 6·15, 6·30, 6·64, 7·74, 8·64, 8·98, 9·15,

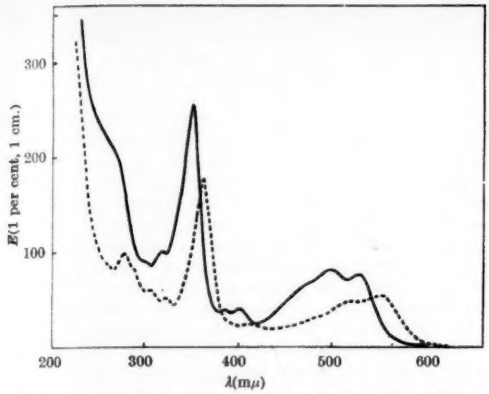


Fig. 1. Ultra-violet absorption spectra of vitamin B_{12} (air-dried, - - - - -) and the hexacarboxylic acid degradation product (———) in water

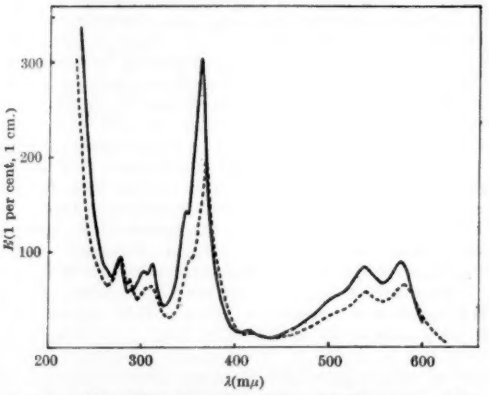


Fig. 2. Ultra-violet absorption spectra of vitamin B_{12} (air-dried, - - - -) and the hexacarboxylic acid degradation product (———) in 0·1 *M* potassium cyanide

9·40, 9·53, 9·85, 10·25 and 12·30 μ. The maximum at 4·67 μ indicates the presence of the cyanide ion, and the absorption in the carbonyl region together with a strong inflexion in the 3–3·8 μ region are consistent with the polycarboxylic nature of the pigment. The virtual absence of strong 'aromatic' bands in the 11·5–14·5 μ region of the spectrum is also noteworthy.

The red needles were unsuitable for X-ray studies, but it is probable that they are a polymorphic modification of the prisms obtained originally, for on one occasion the needles were converted into prisms on keeping in the presence of the mother liquors, and the crystals so obtained were identical (X-ray powder photograph) with those supplied earlier to Dr. Hodgkin.

Later experiments have suggested that the multiplicity of bands obtained by elution of the electrophoretically pure acids from ion-exchange columns with solutions of salts, for example, ammonium acetate, in the absence of excess cyanide, and also the great reluctance of all these compounds to crystallize, is caused mainly by the ease of exchange of anions other than cyanide attached to the central cobalt atom. Work on the changes occurring in the co-ordination state of these acids under various conditions, and further chemical degradations are in progress.

The award of a Beit Memorial Fellowship for Medical Research to one of us (J. R. C.) is gratefully acknowledged.

J. R. Cannon
A. W. Johnson
Alexander R. Todd

University Chemical Laboratory,
Pembroke Street,
Cambridge,
Oct. 15.

[1] Armitage, J. B., Cannon, J. R., Johnson, A. W., Parker, L. F. J., Lester Smith, E., Stafford W. H. and Todd, A. R., *J. Chem. Soc.*, 3849 (1953).

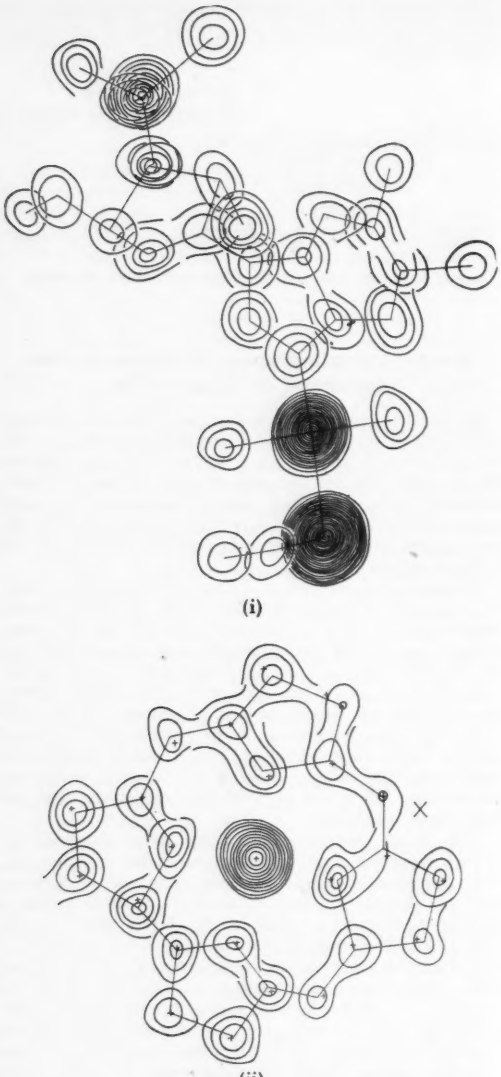
[2] Cannon, J. R., and Gilson, A. R., *Chem. and Indust.*, 120 (1954).

X-ray Crystallographic Evidence on the Structure of Vitamin B_{12}

It is not usual in X-ray analysis to present evidence of part only of a crystal structure. We have, however, reached a point in the investigation of the structure of vitamin B_{12} at which we have obtained strong evidence for the existence of a new type of ring system within the molecule, although we cannot yet describe in detail the nature of the groups attached to it.

Vitamin B_{12} has been shown[1] chemically to contain cobalt, a nucleotide-like group (5 : 6-dimethylbenziminazole 1-α-D-ribofuranoside (2′ or 3′)-phosphate), and a CN group, which together account for $C_{15}H_{18}O_7N_3PCo$ out of a total[2] of approximately $C_{61-64}H_{88-92}O_{14}N_{14}PCo$. There is chemical evidence in addition for the existence of groups which give rise to propanolamine on hydrolysis and to various simple acids on oxidation[2], but a major portion of the molecule is at present of largely unknown character. It is for part of this structure that we now have evidence.

We have obtained complete three-dimensional X-ray data for four crystals: air-dried vitamin B_{12} (two independent sets of data obtained at Oxford and at Princeton), wet vitamin B_{12} (the crystal in its mother liquor), vitamin B_{12}-SeCN (having the CN of B_{12} replaced by SeCN), and, very recently, a red degradation product of vitamin B_{12} from which the nucleotide and propanolamine have been removed. In each of these cases, we have found the positions of the heavy atoms in the crystal by direct Patterson methods, and calculated three-dimensional Fourier series using our observed *F* values and phases based only on the heavy atom positions: cobalt, or cobalt and selenium. The resulting distributions give a crude approximation to the correct electron density series, containing certainly many spurious peaks, but also containing peaks which must correspond to actual atomic positions. We first recognized peaks corresponding to the CN groups in the case of wet and dry vitamin B_{12} and proved our conclusions correct by the substitution of SeCN for CN. We next recognized the general outline of the nucleotide, placed between the cobalt and a second moderately heavy peak—the phosphorus atom—the ribose being linked to the phosphate at the 3-position[4] and one nitrogen atom of the benziminazole nucleus co-ordinated to the cobalt[5]. Between the nucleotide and CN group, and surrounding the cobalt atom, appeared a group of largely planar form, similar in dimensions to a porphyrin nucleus. Attached to this nucleus could be located, though less precisely, various side-chains and possible other ring systems.



(i)

(ii)

Fig. 1. Positions of certain of the atoms in vitamin B_{12}-SeCN derived from the second calculated three-dimensional electron density distribution

(i) The phosphate, ribose, benziminazole, cobalt and selenocyanide groups viewed along the *b*-axis

(ii) The 'planar' group viewed along the *a*-axis

In this figure, and in Fig. 2, the contours drawn are those showing the electron density in sections in the three-dimensional distribution, passing at or near each individual atomic position

In the next series of calculations on air-dried vitamin B_{12}, made both in Oxford and Princeton, it was assumed that the planar group had in outline the form expected for a normal porphyrin. But more detailed comparison of all three series for vitamin B_{12} later obtained in Oxford suggested that, in fact, no true porphyrin was present. Three of the five-membered rings appeared separated each by a single atom, but the fourth seemed directly linked to the first. At this point, different refinements of the first electron density series were calculated. In those derived at Princeton, for vitamin B_{12} itself (J. W.), atomic positions corresponding to a normal porphyrin were inserted, together with successively increasing numbers of positions postulated for the rest of the molecule. In that obtained at Oxford, based on vitamin B_{12}-SeCN, the modified porphyrin-like structure was used, together with postulated positions for all the atoms in the unit cell. Comparison of results provides strong support for the modified planar group. The region of the directly linked five-membered rings appears most distinctly in the vitamin B_{12}-SeCN series. This is illustrated in Fig. 1, which shows the appearance of the planar group, projected along the *a*-axis (ii) together with that of the benziminazole–ribose–phosphate system viewed in the direction of the *b*-axis (i). The atomic positions in both these systems are individually resolved and of the height expected, except perhaps in the region marked *X*.

The atomic arrangement found in the planar group is so unexpected that we hesitated to accept this until we examined the degradation product isolated by Cannon, Johnson and Todd and described in the preceding communication. In this crystal the nucleotide is absent and is replaced by chlorine. The relative disposition of the planar groups in the crystal is entirely different from that in vitamin B_{12} itself; but, within the molecule, we can still trace the same essential pattern. The planar group here is considerably inclined to all three axes; a linear group, CN, projects on one side, and on the other, a heavy peak, the chlorine atom, completes the octahedron of peaks surrounding the cobalt. Fig. 2 shows the peaks directly traced from the first three-dimensional series, viewed from the *a*-direction.

There are a few points that we should make. While we are reasonably certain that atoms exist bonded essentially as shown in Figs. 1 (ii) and 2, we have no evidence of their chemical nature; it is natural to suppose that the four directly attached to cobalt are nitrogen, and the rest carbon. Secondly, we have evidence that the system as a whole is not completely planar, but our results are not yet precise enough for us to know at which points the rings are reduced. Again, though we have indications of the existence of side-chains attached to the nucleus, their corresponding electron density peaks are usually

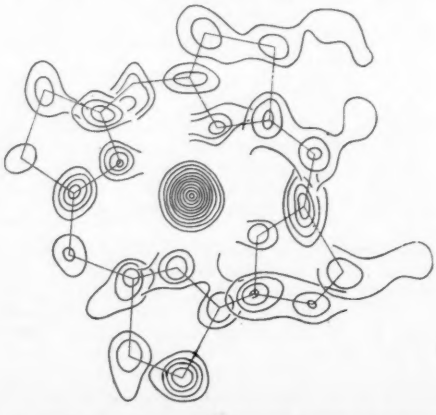


Fig. 2. Positions of the atoms in the 'planar' group as it appears in the first three-dimensional electron density distribution, calculated for the vitamin B_{12} fragment. The structure is viewed along the *a*-axis

much less clear than those of the nucleus itself and we differ among ourselves in our deduction of their nature. A great deal more work is clearly necessary to discover in detail these remaining features of the vitamin B_{12} structure, but from our present experience we now have little doubt that a complete solution of the crystal structure by X-ray analysis is possible.

We are very grateful for gifts of material, and for invaluable conversations, to Dr. Lester Smith, of Glaxo Laboratories, Ltd., and to Sir Alexander Todd and his colleagues. One of us (J. W.) would like similarly to acknowledge a gift from the Merck Laboratories. We have had considerable assistance in our calculations from Miss Ruth Cox, Mrs. U. Ledwith, Mrs. M. Mackay and Mrs. I. Robertson, using machines supplied to us by the British Tabulating Machines, Ltd. Other computing has been carried out for us by the Scientific Computing Service, the National Physical Laboratory, and by XRAC, through the kindness of Prof. Pepinsky. Our researches in Oxford have been very generously supported by the Nuffield Foundation and by the Rockefeller Foundation. We also gratefully acknowledge the award of a fellowship by the International Federation of University Women (to C. B.) and of a grant from the Department of Scientific and Industrial Research (J. P.).

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Oct. 15.

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OBITUARIES

Dr. C. G. L. Wolf

DR. C. G. L. WOLF, honorary consulting biochemist to the United Cambridge Hospitals, died at his home in Cambridge on November 9 at the age of eighty-two.

Charles George Lewis Wolf was born at Niagara, and graduated M.D., C.M. at McGill University. After a period of study in Cambridge and Würzburg, he joined the teaching staff of McGill University as a demonstrator in chemistry, and in 1899 was appointed head of the Department of Physiological Chemistry in Cornell University Medical College. Dr. Wolf relinquished this appointment in 1911, and for a short period worked in the laboratory of the late Sir Frederick Gowland Hopkins in Cambridge.

During the First World War Dr. Wolf held the rank of captain in the R.A.M.C., and in 1919 he became assistant director of the Institute for the Study of Animal Nutrition in the Department of Agriculture at Cambridge. In 1920 he was appointed to a lectureship in bacteriology in the same Department. He left the Department of Agriculture in 1920, and in 1921 became honorary biochemist to Addenbrooke's Hospital, Cambridge. In the same year he was awarded the degree of Ph.D. for a thesis upon the estimation of lactic acid.

Dr. Wolf's work was characterized by a meticulous regard for accuracy in laboratory technique and by a deep knowledge of his subject acquired by extensive reading in the original literature. He carried out research in widely differing fields. From Cornell University came a detailed study of cystinuria, while in 1917 he published a report to the Medical Research Committee (now Council) on the biochemistry of pathogenic anaerobes. This latter work was initiated at a base hygiene laboratory in Boulogne and continued in the Institute for the Study of Animal Nutrition in Cambridge. In 1921 Dr. Wolf published a paper upon the maintenance of the motility of mammalian spermatozoa during storage, and in 1926, in collaboration with Sir Eric Rideal, he published a study of the Wassermann reaction. About this date Dr. Wolf became interested in various serological methods which had been proposed for the detection of malignant tumours in man, and most of his original work from this time until his retirement lay in this field.

A man of strong personality and forthright in expression of his views, Dr. Wolf numbered many eminent colleagues among his friends. He had an exceptionally keen sense of responsibility towards all who worked under him and was always ready with helpful advice upon their problems. Their subsequent careers were a subject of deep and kindly interest to him, and their appreciation was shown by friendships that lasted until the end of his life.

In 1910 Dr. Wolf married Josephine Rebecca Tallerman, who died in 1949. N. R. LAWRIE

M. Albert Demolon

IN the death of Albert Demolon on October 23, France has lost her most distinguished soil scientist. The death of Mme. Demolon in a road accident in 1950 greatly saddened his last days. He will be affectionately remembered by the many hundreds of soil scientists who had the good fortune to know him as a dynamic personality, physically small but mentally and spiritually a giant.

When only twenty-eight years old, he became director of the Station Agronomique at Laon, and during the next eighteen years he threw himself with great energy into the study of the *limons* soils of northern France. His researches were remarkable for the width of their scope. He was just as competent in microbiology as in physics, and was keenly interested in practical agriculture while seeking for fundamental scientific truth. In the middle of this period he suffered the anguish of seeing his laboratory destroyed by bombardment.

In 1927 he was appointed inspector-general of the stations and laboratories of the French Ministry of Agriculture, a post which he retained until his retirement in 1946. Until 1940 he was also director of the Centre National de Recherches Agronomiques at Versailles. In this position he gathered around him an enthusiastic group of research workers, and was their constant source of inspiration. This period closed with the second destruction of his books and records by enemy action, in 1940, and he sustained

further loss when the Centre was bombed in 1944. The fruits of this period are to be found on our shelves in such stimulating books as "Dynamique du sol", "Croissance des végétaux", "Guide pour l'étude expérimentale du sol", "L'évolution scientifique de l'agriculture" and "Génétique des sols".

In all his work we find Demolon rejecting the empirical approach in favour of a sincere attempt to understand the processes at work. He was convinced that this is the surest way to obtain results of practical value in agriculture.

His election to the Paris Academy of Sciences in 1946 marked the beginning of a final period in which he rendered valuable service as adviser to the International Superphosphate Manufacturers' Association, a post which brought him into close contact with many industrial organizations serving agriculture.

R. K. Schofield

NEWS and VIEWS

Carnegie Institution of Washington : Dr. C. P. Haskins

Dr. Caryl P. Haskins, president and director of research of Haskins Laboratories, New York City, has been elected president of the Carnegie Institution of Washington in succession to Dr. Vannevar Bush, who will retire on January 1, 1956. Dr. Haskins was born in Schenectady, New York, in 1908, and graduated from Yale University in 1930. After four years in the Research Laboratory of the General Electric Company and graduate study at Harvard University, where he received a Ph.D. in 1935, Dr. Haskins established the Haskins Laboratories, a non-profit scientific and educational foundation. This foundation has for eighteen years devoted itself mainly to basic scientific research and research training in selected pioneer fields. With a small staff supported by private funds and grants from various foundations, its original activities were confined mainly to the fields of biochemistry and biophysics ; but in recent years it has moved into the field of psychoacoustics, which involves a new approach to some of the fundamental aspects of speech. One of Dr. Haskins's books, "Of Societies and Men" (1950), is particularly interesting in that it sets forth in a novel way significant trends in the formation, growth and duration of societies, drawing information from evolution, palæontology, genetics and biochemistry, and tracing parallels in the social evolution of many different kinds of organisms. Among its conclusions is that over-regimentation and over-specialization destroy in time the self-reliance and flexibility of individuals in the society, and the society then often fails to adjust itself to changes in environment. During the Second World War, Dr. Haskins served with the National Defense Research Committee and the Office of Scientific Research and Development, and since the War has acted as a consultant to the Departments of Defense and State. He has been a research professor in biophysics at Union College, Schenectady, since 1937, and president of the National Photocolor Corporation of New York City since 1938. In 1948 he was awarded the Certificate of Merit and in the same year received from Great Britain the King's Medal for Service in the Cause of Freedom.

Atomic Energy Authority : Appointments

Mr. Eric H. Underwood has been appointed director of public relations to the United Kingdom Atomic Energy Authority. He will take up his duties early in the New Year. He goes to the Authority from the Central Office of Information, where he was director of the Photographs Division and, earlier, chief editor of overseas magazines. Mr. Underwood, who is forty-one years of age, was educated at Dulwich College. He was a provincial newspaperman until 1940, when he joined the Royal Air Force. At the end of hostilities in Europe he was seconded to the Control Commission for Germany as a squadron-leader press officer until his demobilization at the end of 1945. In January 1946 he was appointed deputy director of public relations at the newly formed Control Office for Germany and Austria, and transferred to the Foreign Office in the following year, going to the Central Office of Information in 1949. Mr. Stanley White, who has been acting as press officer on secondment from the Ministry of Supply, has now been appointed to that post with the Authority. The Authority's Press Office will move from Bedford Chambers to St. Giles Court, St. Giles High Street, London, W.C.2, early in 1955.

Harwell Isotope School

The Harwell Isotope School, which since it was founded in 1951 has had 329 students from twenty-nine different countries, is now preparing its programme for the forthcoming year. Training is given at this School in the applications of radioactive materials in research and industry and in the techniques of producing, measuring and handling such materials. Countries besides the United Kingdom from which students have already been trained are Australia, South Africa, Argentine, Austria, Belgium, Brazil, Chile, Denmark, Egypt, Finland, France, Germany, Greece, Holland, India, Ireland, Israel, Italy, Lebanon, Norway, Pakistan, Portugal, Spain, Sweden, Switzerland, Turkey, U.S.A. and Yugoslavia. The courses, which last for four weeks, include both lectures and practical work in the laboratory. Students should be graduates of a university. The courses for early 1955 are already fully booked, but there are at present vacancies on Course 27 (April 25–May 20) and Course 28 (June 27–July 22). Further information can be obtained on application to : The Isotope School, A.E.R.E., Harwell, Berks.

International Tin Research Council and Tin Research Institute : Appointments

Following the retirement at the end of this year of Mr. John Ireland, Dr. Ernest S. Hedges will become director of the International Tin Research Council and director of the Tin Research Institute. In addition, Dr. W. E. Hoare and Mr. W. R. Lewis have been appointed assistant directors. Dr. Hedges, who was educated at the Universities of Manchester and London, was at one time Darbishire Fellow of the University of Manchester, and later lecturer in chemistry in the University of London. He was appointed to the staff of the Tin Research Institute in 1932 and has been director of research since 1939. He is the author of several books on chemistry and metallurgy, and of more than a hundred research

papers. Dr. Hoare is head of the Tinplate Section of the Tin Research Institute, having originally begun his career as a metallurgist with the Talbot Motors Company, and Mr. Lewis is development manager at the Institute.

United States Research Fellowships to British Scientific Workers

RESEARCH fellowships tenable in American institutions under a technical assistance programme sponsored by the United States Foreign Operations Administration have been awarded by the National Academy of Sciences, Washington, on the nomination of the Royal Society, London, to five British scientific workers as follows: G. V. Chester, scientific officer, Radar Research Establishment (Ministry of Supply), to work at Yale University, under Prof. J. G. Kirkwood, in the field of statistical mechanics and, in particular, on the molecular theory of fluids; Dr. R. A. Gibbons, research assistant, Department of Biochemistry, Lister Institute of Preventive Medicine, London, to work at the Ohio State University, Columbus, under Prof. M. L. Wolfrom, on problems in connexion with the human blood-group substances; C. G. James, research student in the Department of Physical Chemistry, Cambridge, to work in the University of California, Berkeley, under Prof. Leo Brewer, in the general field of high-temperature thermochemistry and flame equilibria; I. M. Mills, research student in the Department of Chemistry, Oxford, to carry out research in infra-red spectra at the University of Minnesota, under Prof. Bryce Crawford, jun.; Dr. G. L. Squires, a senior research Fellow at the Atomic Energy Research Establishment, Harwell, to work under Dr. Robert Oppenheimer in the Institute for Advanced Study, Princeton, New Jersey, for about three months and then under Drs. John and Leona Marshall in the Institute for Nuclear Studies of the University of Chicago, on experiments in meson physics. This brings to sixteen the number of awards to candidates from the United Kingdom in a programme which, instituted in 1953, is intended to enable some hundred and fifty outstanding young scientific workers from fourteen Western European countries to carry out advanced study for up to two years at American universities and research institutions; part of the time may be spent in American industrial or applied science research laboratories. The grants are worth about 3,300 dollars (approximately £1,180) a year plus travel expenses.

The Nature Conservancy: Annual Report

ACCORDING to the report of the Nature Conservancy for the year ended September 30, 1954 (see p. 1159 of this issue), by the end of that year the Conservancy had notified under Section 23 of the National Parks and Access to the Countryside Act, 1949, 1,098 sites of special scientific interest in England (coming under sixty-eight planning authorities) and 148 in Wales (coming under thirteen authorities). Progress in Scotland was slower; but by the end of the year seventy-seven sites had been notified to twelve authorities. By the end of the year 528 geological sites out of the 634 proposed for conservation had been inspected, and nearly two hundred photographs of such sites were taken. Only at the beginning of the year did it become possible to trace and write on a large scale to the owners and occupiers of such sites, which vary widely both in size and in the character of their scientific interest. Considerably less than half the owners notified have replied, the great majority promising co-operation; only a small minority has taken exception. In future, where tenants and proprietors can be traced, they will be consulted before further areas are notified to local planning authorities; but it is emphasized that notification is merely a means of informing authorities, owners and occupiers of the fact that they have something of outstanding natural and scientific interest on their land, and the Conservancy has been encouraged by the readiness of many owners to welcome scientists and to see that the scientific interest is preserved.

The report also deals at some length with the new statutory responsibilities of the Conservancy under the Protection of Birds Act, 1954, which came into force on December 1. Under Section 10 of that Act, the Conservancy is responsible for issuing licences in connexion with interference with bird life for scientific or educational purposes for work sponsored by the Conservancy; and it is also one of the bodies empowered to nominate an authorized person for pest control and other specified purposes. Despite certain difficulties, the Nature Conservancy believes that it will be possible to reach agreement on a broad policy in regard to wild-fowl refuges, which will combine the requirements of nature conservation with those of sportsmen, particularly wild-fowlers.

Viruses and the Control of Insect Pests

OUTBREAKS of insect pests are often brought to an end by outbreaks of infectious disease, and many attempts have been made to control harmful insects by spreading disease among them. In the past the results have been disappointing: the infective organisms have soon lost their virulence. But in recent years some strikingly effective epidemics of disease among insect pests have led to a renewed interest in the method. In 1945 the population of the spruce sawfly in eastern Canada, after reaching alarming proportions, just melted away before a virus disease. This episode served to focus attention on the insect viruses, and that has led in turn to the practical use of introduced virus diseases for insect control, on one hand, and a great increase in our knowledge of these diseases, on the other. In the November number of *Discovery*, Dr. Kenneth M. Smith, of the Agricultural Research Council's Virus Research Unit, at Cambridge, contributes an interesting article which outlines both the fundamental knowledge of insect viruses that has recently been obtained and some of the practical achievements. Thus the alfalfa butterfly in California has been effectively controlled by spraying the crop with stored polyhedra obtained from diseased caterpillars, and the pine sawfly in Canada has been controlled by a virus of polyhedral type procured from Sweden. A very interesting discovery is that some virus diseases are not highly specific, but can attack a number of different species of Lepidoptera; sometimes the virulence of the infection can be increased by mixing two viruses. In general, the persistent nature of the viruses and the fact that they do not affect the natural enemies of the pests make them a promising alternative to insecticides.

Third International Congress of Biochemistry, Brussels

THE Third International Congress of Biochemistry will be held in Brussels during August 1–6, 1955,

under the presidency of Prof. E. J. Bigwood, rector of the University of Brussels. The scientific programme of the Congress will be made up of symposia, sessions for members' communications and general lectures. There will be, in all, thirty-two symposia, which will cover the following seventeen topics: organic chemistry of substances of biological interest; chemistry and physical chemistry of proteins and polypeptides; chemistry and physical chemistry of nucleoproteins and nucleic acids; enzymology; intermediary metabolism; biological oxidations and oxidative phosphorylations; biochemical regulations; biochemistry of the cell; biochemistry of muscle and the central nervous system; biochemistry of micro-organisms; plant biochemistry and biochemistry of the soil; chemical zoology; nutrition; chemical pathology; chemical pharmacology; clinical chemistry; and industrial biochemistry. The two general lectures, to be given at the opening and closing sessions of the Congress respectively, will be as follows: Prof. Carl Martius (Physiological Chemical Institute of the University of Würzburg) speaking on "Thyroxin und Oxydative Phosphorylierung", and Prof. Vincent du Vigneaud (Cornell University Medical College, New York) on "The Hormones of the Posterior Pituitary". Those intending to read papers must send in abstracts, not exceeding two hundred words, to the General Secretary of the Congress before April 1. The registration fee for the Congress is 600 Belgian francs (about £4 or 12 dollars) for active participants or 100 francs for associate members. Registration can be made through the American Express Co., Inc. (51 Cantersteen, Brussels, or any of its offices elsewhere), and should be made as soon as possible, in any event not later than May 31. All scientific communications should be addressed to the General Secretary of the Congress at 17 Place Delcour, Liège, from whom further information can be obtained.

Royal Society: Officers for 1955

The following have been elected officers and council of the Royal Society for the ensuing year: *President*, Dr. E. D. Adrian; *Treasurer and Vice-Presidents*, Sir Thomas Merton; *Secretaries and Vice-Presidents*, Sir Edward Salisbury and Sir David Brunt; *Foreign Secretary*, Sir Cyril Hinshelwood; *Other Members of Council*, Prof. W. Baker, Prof. F. W. R. Brambell, Prof. F. Dickens, Sir Alan Drury, Prof. J. H. Gaddum, Prof. L. Howarth, Mr. A. E. Ingham, Prof. W. B. R. King, Prof. W. H. McCrea, Prof. K. Mather, Sir Edward Mellanby, Prof. P. B. Moon, Prof. W. H. Pearsall, Mr. J. A. Ratcliffe, Prof. J. M. Robertson and Dr. C. Sykes.

Mond Nickel Fellowships, 1954

The Mond Nickel Fellowships Committee announces the following awards for 1954: M. Brownlee (Dorman, Long and Co., Ltd., Redcar), to study British, Continental and American hot and cold metal basic open-hearth steel-making with particular reference to furnace design and construction and factors affecting ingot quality; R. D. Butler (Imperial Chemical Industries, Ltd., Liverpool), to study mineral dressing practice in Great Britain, on the Continent and in the United States and Canada, with particular reference to the design, layout and operation of small-scale mills; F. B. Peacock (Dorman, Long and Co., Ltd., Middlesbrough), to study rolling mill operation and maintenance with particular reference to soaking pits, blooming mills and the production of universal beams, structural sections and rails; A. M. Sage (British Iron and Steel Research Association, London), to study the manufacture and fabrication of structural steels in the United Kingdom, Europe, the United States and Canada.

Announcements

We regret to announce the death of Dr. G. F. C. Searle, F.R.S., formerly University lecturer in experimental physics in the University of Cambridge, on December 16, aged ninety.

The title of emeritus professor has been conferred by the University of Sheffield on Prof. I. C. F. Statham, who has recently retired from the chair of mining in the University (see *Nature*, August 7, p. 250).

The Council of the Royal Society has awarded Locke Research Fellowships to the following: M. de Burgh Daly, to work on carotid sinus reflexes and hæmodynamics of the pulmonary circulation, at University College, London; J. C. F. Poole, to work on the effects of fat absorption and blood coagulation and thrombosis, at the Sir William Dunn School of Pathology, Oxford.

Mr. A. D. Knox, lecturer at the London School of Economics and Political Science, has been appointed to the University readership in economics, with special reference to the economics of underdeveloped countries, tenable at the School. The title of reader in economics in the University of London has been conferred on Dr. A. W. H. Phillips in respect of his post at the London School of Economics and Political Science.

On the occasion of the annual general meeting of the Manchester and District Section of the Royal Institute of Chemistry, an exhibition of chemical laboratory apparatus, instruments and techniques will be held in the Manchester College of Technology and will be open to the public on January 5 (2–8 p.m.) and January 6 (10 a.m.–8 p.m.). Special emphasis will be laid this year on distillation and fractionation equipment.

A complete and informative catalogue of recent publications of the Institute of Physics, covering the "Physics in Industry" series, the Institute's two monthly journals and their supplements, the "Monographs for Students" series and numerous reports and pamphlets, together with various books published for the Institute by Edward Arnold (Publishers), Ltd., is now available and can be obtained free from the offices of the Institute, 47 Belgrave Square, London, S.W.1.

Dr. Maurice Cook, joint managing director of the Metals Division, Imperial Chemical Industries, Ltd., has been elected chairman of the British Non-Ferrous Metals Research Association in succession to the Hon. R. M. Preston, who retires from office at the end of this year. In addition to his many contributions to science and technology in industry, Dr. Cook is distinguished for his services to the metallurgical profession. He is a past president of the Institution of Metallurgists and senior vice-president and president-elect of the Institute of Metals, and, among his many activities connected with the Research Association, he has been chairman of the Research Board since 1950.

COMMONWEALTH OCEANOGRAPHIC CONFERENCE

THE idea of a Commonwealth Oceanographic Conference was first put forward at a meeting of the National Oceanographic Council in January 1953. It arose from arguments that the change of emphasis in oceanography, from exploration and survey to research directed towards the precise understanding of the basic physical and biological processes, makes it necessary to devote more effort to theoretical and experimental work. For example, biologists as well as physicists want to know more about the changes in the surface currents and the speeds and variations of the slow but powerful deep-water movements, and it is no longer possible or reasonable to attempt to keep a watch on them all with a network of oceanographic observations like that used in meteorology. The only practical thing is for oceanographers to learn how the water movements are governed by atmospheric pressure, wind and climate so that they can use the meteorological data, supplemented every now and then by their own upper- and lower-water observations.

It would, no doubt, be wrong to suggest that oceanographers took up the subject because they found mathematical and physical sciences too difficult and unattractive; but they have been rather slow in applying the precise techniques of these sciences to marine research. There is more than sufficient interest and profit in the study of the marine animals and plants to keep the marine laboratory busy; but there would be just as much interest and profit in the study of the magnificent interplay between sun, water, air and earth if only we knew rather more about it to begin with. To increase our knowledge the subject must be made attractive to men who do not mind facing up to the difficulties of fluid mechanics. The experienced investigators who have done so much exploration and survey and built up a realistic basic picture can scarcely be expected to turn their hands to the fresh intricacies of such new tasks.

The progress in any science can probably be measured by the interest which the universities take in it; and in oceanography their interest, with one or two notable exceptions, is limited to the biology of the coast and shallow seas. This is understandable, since the problems are interesting and important, and there is much that can be fitted conveniently into university life. As soon as the collection of data becomes too expensive for university departments, and the problems too difficult to afford reasonable expectation that a student can make sufficient progress in two years to sit for a higher degree, the work has to be left to State-aided marine laboratories, and men have to be paid to do it. Even then it is rather difficult to attract first-class men, and a fair number are needed, since nothing less than a team with similar interests is likely to make much headway with a really backward subject.

Most countries of the British Commonwealth engage in oceanography on a considerable scale, dividing their resources between long-term research and the application of existing knowledge to their immediate problems. They all want to increase their activity; but the difficulties of attracting sufficient men with special qualifications and experience, the rising cost of designing and constructing the necessary apparatus and of building, operating and maintaining ocean-going research ships will, sooner or later, make some sharing of the basic studies essential.

The purpose of the Commonwealth Oceanographic Conference held during October 18–22 at the National Institute of Oceanography at Wormley, which was attended by delegates and observers from all Commonwealth countries as well as representatives of authorities interested in marine research in the United Kingdom, was to review the progress of oceanographic research in the Commonwealth, to discuss what measures might be taken to promote its extension, and to further the co-operative use of the available effort and facilities.

The Conference considered the applications of oceanographic research to defence, coastal engineering, shipping, meteorology and fisheries, and concluded that more use could be made of oceanographic research. It was also generally agreed that the investigation of local problems would be furthered by a better understanding of the basic physical and biological processes. It was agreed that the processes most deserving attention are those involved in the interchange of energy between the atmosphere and oceans, response of the sea surface to winds and pressure changes, general circulation of the oceans, distribution of marine organisms and organic production in the oceans. It was recognized that there are other important aspects, but progress in them is more satisfactory, and the immediate need is to direct attention to subjects which require much closer study before our understanding of the underlying principles of oceanography can be sufficient to allow real progress.

The Conference agreed on a co-operative scheme for lending equipment that is expensive, difficult to obtain, and probably only used occasionally, and arranged for the scheme to be started by the National Institute of Oceanography, which had announced its intention to build up a reserve of equipment.

Arrangements for disseminating information similar to those used by the Fuel Research Organization and the Aeronautical Research Council in Commonwealth countries were also agreed. The subject was divided into ten branches, for each of which a chief co-ordinator, located somewhere in the Commonwealth, was proposed: a national representative would pass reports of work done in his country in each of these branches to the appropriate chief co-ordinators, who would summarize and edit information and distribute it annually. It may be doubted whether such a scheme will succeed, but oceanography is a science in which publication, with reasonable confirmation, tends to lag well behind the formation of ideas, and though the tasks of the national representatives and the co-ordinators will be heavy, men with great enthusiasm may produce very useful results. Some benefit will be obtained from the mere fact that the national representative has to judge what contribution his country is making to the systematic development of the subject rather than to knowledge of local conditions.

The need for training more oceanographers was emphasized, and it was decided that the universities should be asked to help by teaching oceanography and doing all they can to encourage postgraduate research in marine physics as well as marine biology.

The Conference endorsed the programme of the National Institute of Oceanography, and considered that its attempt to concentrate on the basic problems, which will benefit the Commonwealth countries by helping them to solve their local problems, should be supported as fully as possible.

The First Lord of the Admiralty, the Right Hon. J. P. L. Thomas, and the Civil Lord, Mr. Simon Wingfield Digby, chairman of the National Oceanographic Council, did much to encourage the work of the Conference. They were hosts at a reception to all members after the first day's session and at a dinner, at which the First Lord presided, given in honour of the Commonwealth representatives, at the close of the meetings.

NEW FORMS OF THERMIONIC CATHODE

A COLLOQUIUM on new forms of thermionic cathode, sponsored by the Institute of Physics and the Physical Society, was held on October 21 at Hirst Hall on the estate at Wembley of the General Electric Company, Ltd., An introductory survey was given by D. A. Wright (G.E.C., Wembley), who pointed out that, for continuous operation for many thousands of hours, none of the established cathodes (Nos. 1, 3 and 9 in Table 1) can be relied upon to give more than 1–2 amp./cm.². The oxide cathode will give some tens of amp./cm.² in short pulses, but is limited for continuous high current by its sensitiveness to imperfect vacuum, by the dielectric properties of the coating and by evaporation and electrolysis of coating material. Thus, to improve the performance, a cathode with metallic properties is desirable, with a low rate of loss of emissive material. The lowest-temperature emitter obtainable without a dielectric coating appears to be that which maintains a monatomic layer of barium on a metal surface, possibly with some oxygen present. The work function of such a cathode is 1·6–2·0 eV., so that it must be operated at 950° C. or more. At these temperatures, surface barium is rapidly lost by evaporation, and must be replaced from a reservoir in the cathode. The next four papers at the colloquium described cathodes of this type.

Dr. A. Venema (Philips, Eindhoven) described the three forms of Philips dispenser cathode. In the original *L* cathode (No. 5 in Table 1) the reservoir is of barium–strontium carbonate, which decomposes to oxide during pumping and is placed beneath a plug of porous tungsten. The work of Rittner has clarified the mechanism of these cathodes, indicating that barium is formed following reduction of the oxide by the tungsten, and diffuses through the pores as vapour by Knudsen flow. A complete covering of barium on tungsten is maintained by diffusion over the outer surface of the tungsten particles. The life, as shown in the table, exceeds eight thousand hours at a brightness temperature of 950° C., at which the saturated emission is 1·3 amp./cm.². The life is determined by evaporation, and decreases by a factor of 2½ per 50 deg. C. rise of temperature. The impregnated cathode has similar properties, and is formed by heating a porous tungsten plug in contact with barium aluminate at 1,750° C. in vacuum. The aluminate penetrates the pores, and in operation is reduced by the tungsten. A third type of cathode is being developed, in which tungsten powder and barium aluminate are mixed in powder form, pressed and sintered, again at 1,700–1,800° C.

In discussing the chemical reactions which can be utilized to supply barium to a tungsten surface, Dr. H. Huber (C.S.F., Paris) said that the compounds barium aluminate, silicate, titanate, thorate and tungstate have been considered. The work of Eisenstein, John and Affleck has shown what reducing agents are appropriate for each compound, and Dr. Huber described the results of his study of the emission of cathodes formed by mixing the powdered oxide, tungsten and a suitable reducing agent, pressing and heating at 1,300° C. The preferred cathode is '103' (No. 6 in Table 1), containing five molecular parts of barium tungstate (Ba_3WO_6), fifteen molecular parts of aluminium powder and eighty of tungsten powder, though similar results are obtained if the aluminium is replaced by tungsten carbide, and molybdenum can replace the tungsten powder. Presintering at 1,500° C. is found to be necessary to give long life.

It is not possible to form a cathode by mixing barium/strontium carbonate with tungsten, as there is a reaction which prevents subsequent reduction of the oxide to free barium. The carbonate can, however, be mixed with a more inert metal containing a little reducing agent. Dr. J. M. Dodds (Metropolitan-

Table 1

Type	Operating temperature	Radiated power (watts/cm.²)	Maximum usable d.c. emission (amp./cm.²)	Life† (hr.)	Work function (eV.)	Richardson *A* value
(1) Tungsten	2,600° K.	80	0·5	10,000	4·5	60
(2) Tantalum	2,400° K.	55	0·5	10,000	4·1	37
(3) Thoriated tungsten	2,000° K.	25	1–3	5,000	2·6	3
(4) Lanthanum boride	1,680° K.	40	1	> 250	2·6	25
(5) Philips dispenser (barium–tungsten)	950° C.B.‡	4*	1·3	8,000	2·1	100
(6) Huber 103 (barium–tungsten)	1,050° C.B.	6*	1·0	4,000	1·72	3
	1,200° C.B.	8*	4–5	~ 400		
(7) Dodds (barium–nickel)	950° C.B.	3·3*	6	Not yet measured		
(8) Beck (barium–nickel)	1,340° K.	3·7*	3	3,000	1·8	20
	1,270° K.	3·0*	1·5	9,000		
(9) Oxide cathode	1,100° K.	2·8	0·5	~ 3,000	1·2	~ 1
	1,200° K.	4·2	1·0	< 1,000		

* These figures assume thermal emissivities for Nos. 5 and 6 as for tungsten wire (that is, 0·25) and for Nos. 6 and 7 as for nickel sheet (that is, 0·2). In practice they are likely to be higher.

† The figures quoted for life are rough indications only, in all cases.

‡ Temperatures in ° K. are true temperatures. Temperatures in ° C.B. are pyrometer brightness temperatures.

Vickers) and A. H. Beck (Standard Telecommunications Laboratories, Ltd.) described cathodes of this type, formed by mixing 30–40 parts by weight of carbonate with 70–60 parts of nickel powder, pressing and sintering. Dr. Dodds adds as reducing agent 0·1 per cent silicon, and presses at 10 tons/in.². Mr. Beck uses 1 per cent zirconium hydride as reducing agent, and presses at 80 tons/in.². His study of the work function has indicated that the activated cathode is nickel with 70 per cent of the surface covered with barium. The temperature coefficient of the work function is $1{\cdot}4 \times 10^{-4}$ eV./deg. C.

C. P. Lea-Wilson (Services Electronics Research Laboratory, Harlow) described a high-temperature magnetron cathode which emits from thorium-on-tungsten. This again is formed by pressing and sintering, but employs either thorium oxide or thorium metal (about 2 per cent) mixed with tungsten carbide and tungsten. With thoria, gas is liberated over a long period of operation, and about 10 per cent of carbide is necessary to obtain emission. The thorium gives rapid outgassing and activation, and is to be preferred. In the discussion, Mr. Lea-Wilson said that the carbide is desirable even when thorium is used, possibly because it minimizes surface oxidation. There is no information as to whether thorium carbide is formed. The cathode gives a pulsed emission of 20 amp./cm.² at about 1,700° C., and a number of valves have been operated satisfactorily for more than a thousand hours.

Another high-temperature cathode using lanthanum boride as the emitter was described by B. N. Watts (British Thomson-Houston Co., Ltd., Rugby). This is formed by reaction of metal and boron in hydrogen at 1,400° C., and is either painted and sintered on a tantalum filament, or pressed, sintered, machined and heated indirectly. It is activated at 1,600° C. and gives 1 amp./cm.² at 1,400° C., the d.c. and pulsed emission being equal. No long-life test information is yet available.

Finally, P. O. Hawkins (Services Electronics Research Laboratory, Baldock) described an oxide cathode in which the normal disadvantages are overcome by applying the coating on the inner surface of a hollow box, and extracting the electrons through a small hole. From a hole $\frac{1}{3}$ mm. diameter, spaced 2 mm. from the anode, the current is very small below 920° C. At high temperatures the current increases at first rapidly with voltage, and then linearly and less rapidly. It exceeded 50 m.amp. at an anode voltage of 5 kV. at 1,230° C. This current if uniform over the hole would be 60 amp./cm.²; but, in fact, the beam is found to be hollow, and the current for varying hole size varies with the perimeter. The mechanism is not understood.

In discussion, Dr. D. Gabor suggested that Mr. Hawkins's cathode contains a plasma from which electrons emerge with high velocity, and the latter agreed that it does not appear to contain an electron gas at the cathode temperature. Dr. P. N. Daykin asked whether n small holes would multiply the emission, and was told that this is so, giving an n-fold multiplication until the hole spacing becomes of the order of the hole diameter. M. E. Haine said that the beam current density per unit solid angle has a definite limit, so that a quotation of amp./cm.² can be misleading. In reply to a remark by Dr. O. Klemperer, Mr. Hawkins said that low-voltage measurements have not been made. Questioned about secondary emission, Mr. Watts said that the secondary-emission coefficient of lanthanum boride has not been measured. Mr. Beck said that his cathodes have a value 10 per cent higher than that for pure nickel, while Dr. Venema agreed that the value for the L cathode is between 1·0 and 1·5. Dr. Huber discussed with Dr. Venema the reason for the former's failure to obtain good emission from barium–aluminate tungsten mixtures containing no additional reducing agent, and it appeared that the barium content and the sintering temperature are the important factors.

BRITISH WEED CONTROL CONFERENCE, 1954

THE second British Weed Control Conference was held at Harrogate during November 2–4 and was attended by four hundred delegates, including representatives from the British Colonies and most European countries. The Conference was organized on lines similar to those of the first one in 1953; that is, the emphasis was on the technology of weed control rather than on the underlying fundamental principles. The papers were divided into two broad classes, one concerned with general reviews of various aspects and the other with research reports on individual topics. The general papers again fell into two groups: the first related to the problems of commercial application, the efficiency of the available spraying equipment, the rotation of weed-killers, schemes for the approval of commercial products, and the legal aspects of spray damage; the second group contained surveys of modern developments in the use of herbicides and the associated problems of the dispersal of weed seeds and the role of mechanical cultivation.

Dr. W. G. Templeman (Jealott's Hill Research Station) reviewed the present position of herbicides in British agriculture. He pointed out that, although great advances have been made in the control of annual weeds in cereal crops, there still remain some relatively resistant and extremely important weeds, such as *Avena fatua* and *Alopecurus agrestis*, for which there are no adequate methods of control. He also emphasized that, while for many crops herbicidal applications are proving of great practical value, the position is far less satisfactory for root crops and many horticultural crops. In the past, too much stress has been laid on the total eradication of the weeds, and in many instances a better approach would be an endeavour to inhibit growth through the disorganization of the physiological processes. For example, 2,4,6-tribromophenylnitramine causes germinating seedlings to lose their capacity to react to tropic responses; but so far no compound with these characteristics has been discovered which is sufficiently selective.

While agreeing that herbicidal applications are playing an important part in British agricultural systems, Prof. H. G. Sanders (University of Reading) nevertheless felt that there is some danger that effective cultivation is not being fully appreciated. He was of the opinion that the hoe does more than kill the weeds and that its use in many circumstances is of direct benefit to the crop.

The organization of weed control investigations sponsored by the United States Department of

Agriculture was outlined by Dr. C. Warren Shaw (Beltsville, Maryland). Apart from the screening of new compounds and some fundamental and development work at Beltsville, similar investigations are being carried out in all parts of the United States under the general direction of four regional co-ordinators. All this work in turn is linked with similar projects being undertaken by individual States. Dr. Shaw also outlined some of the modern developments which are taking place, particularly in relation to the value of such new herbicides as 2,3,6-trichlorobenzoic acid for the pre-emergence spraying of maize and sorghum, 2,4,5-trichlorophenoxypropionic acid for the control of woody plants in cotton-growing areas, 2,2-dichloropropionic acid for the eradication of graminaceous species, and the likely value of phenyl-substituted ureas for the control of weeds in sugarcane, pineapples, asparagus and possibly cotton. The other materials referred to included N-(1-naphthyl)phthalamic acid as a selective herbicide in cucurbitaceous crops and 3-amino-1,2,4-triazole, which apart from its merit for defoliating cotton is likely to find a variety of uses as a herbicide.

An interesting new development in selective weed control was described by Prof. R. L. Wain (Wye College). In seeking to unravel the basic physiological actions of substituted phenoxyacetic acids, evidence has been obtained of the β oxidation of ω-phenoxyalkylcarboxylic acids. The alternation of biological activity with an increasing number of carbon atoms in the side-chain is only exhibited by some species. From these observations it is concluded that some species do not contain enzyme systems capable of breaking down the original compound to the parent phenoxyacetic acid. Thus, species which do not contain such enzyme systems will be resistant, while others which do will be susceptible. Pot and small-scale field experiments have confirmed this conclusion, and among the susceptible species are many common weeds, such as *Urtica urens*, *Chenopodium album*, *Sinapis arvensis* and *Cirsium arvense*, while resistant crops embrace red and white clovers, parsnips, celery, flax, maize, etc. A survey of the biological activities of γ-phenoxybutyric acids has also demonstrated that the position and number of methyl and chlorine atom substitutions in the benzene ring alter the properties of the molecule, which in turn alter the selective action between species. It is therefore evident that, with the introduction of compounds with odd numbers of carbon atoms in the side-chain, the value of substituted phenoxyacetic acids as selective herbicides will be extended to new crops.

Sir Edward Salisbury (Royal Botanic Garden, Kew) gave an account of the main factors relating to the persistence of weed seeds under British conditions and the principles of dispersal. Examples of the introduction and rate of spread of foreign species, such as *Cardaria draba*, were described. Once the initial introduction has taken place, the spread of the species is dependent upon a number of factors. For example, *Veronica persica*, which seeds very freely, has spread all over the country, whereas *Veronica filiformis*, which seeds but rarely because it is self-incompatible, is still highly localized in its distribution but may extend its area in the locality through vegetative propagation. In discussing the various agencies which lead to weed dispersal, it was pointed out that for birds the interval between ingestion and evacuation varies between thirty minutes and three hours or more, according to the species; thus, the rate of spread is greater where the seeds are readily taken by the larger birds, such as pigeons. Other aspects of seed dispersal by machinery and the laws governing injurious weed seeds and noxious weeds were discussed respectively by F. Coleman (Cirencester) and J. A. McMillan (National Agricultural Advisory Service).

The forty-six research reports presented at the Conference were considered in a number of groups, of which the most important related to weed control in horticulture, grassland, legumes, cereals, row crops and flax, while other aspects considered were the eradication of perennial grasses, the techniques of application both in greenhouse experiments and field trials, and the eradication of woody species under temperate and tropical conditions.

Apart from the selective control of weeds in peas and carrots, in other horticultural crops little progress has been made in the development of compounds which are selective when applied as a post-emergence spray, and most of the contributions bearing on horticulture reviewed the merits and defects of well-established practices. H. A. Roberts (National Vegetable Research Station) discussed the problems connected with the use of pre-emergence techniques and thought that, for contact pre-emergence applications, oil formulations containing pentachlorophenol are of considerable promise. For the control of dicotyledonous annual weeds in peas, dinitro*sec*-butylphenol is still the most widely used compound, both in Great Britain and on the Continent of Europe, although H. I. Petersen (Denmark) stated that good results have been achieved by using a mixture of dinitro*sec*butylphenol and sodium 2-methyl-4-chlorophenoxyacetate. The potential value of *iso*propylphenylcarbamate and its 3-chloro-derivative for the selective elimination of wild oats (*Avena* spp.) and other weeds in peas was also discussed. The best degree of control has been obtained by incorporating the herbicides in the soil before sowing the crop, but no final conclusions can yet be reached as to the direct action of these materials on peas.

The papers on the elimination of perennial weeds from grassland illustrated the complexity of the problem, and the value of the ecological approach in relation to the use of herbicides was emphasized by M. Norman (Grassland Research Station) and A. D. Q. Agnew (Bangor). Turning to other agricultural crops, I. S. Frederiksen (Denmark) and K. Fröier and H. Zienkiewicz (Sweden) advocated the use of mixtures of sodium dinitro*ortho*cresylate and sodium methylchlorophenoxyacetate in fibre flax, while W. Q. Connold and E. I. Prytherch (National Agricultural Advisory Service) commented on the value of sulphuric acid for the control of annual weeds in Brassica crops.

Of the papers dealing with weed control in cereals, there was much interest in the contribution of Dr. P. Riepma (Holland), who described the results obtained when weed-free crops of autumn-sown wheat and rye were sprayed with dinitro*ortho*cresol at various times during the winter period. In many instances, appreciable gains in yield were recorded, more particularly in rye, and the maximum gains occurred when spraying took place at the four- to five-leaf stage of development. Dr. Riepma was of the opinion that these increases could not be explained in terms of the nitrogen contained in the herbicide,

since the response was independent of the level of available nitrogen supply.

S. Andersen (Denmark) and Prof. B. Rademacher (Germany) gave accounts of experiments which sought to correlate weather conditions with the effects of substituted phenoxyacetic acids on cereals. J. D. Fryer and J. G. Elliott (Oxford) and T. C. Breese (Plant Protection, Ltd.) were in general agreement that, while wheat and barley cannot safely be sprayed until the plants reach the five-leaf stage, the optimum time to spray oats with 2-methyl-4-chlorophenoxyacetic acid is in the one- to four-leaf stage. For perennial grasses the importance of the stage of development in relation to the timing of spray applications was illustrated in the contribution of R. S. L. Jeater (National Institute of Agricultural Botany), who described the complex inter-relationships between species, time of application and the abnormalities induced in the flower primordia and inflorescences.

Three papers were devoted to the means of controlling *Agropyron repens*; in Great Britain the emphasis has been on sodium trichloroacetate, while in Sweden, so Prof. H. Osvald and Dr. E. Aberg reported, comparisons are being made of sodium chlorate, sodium trichloroacetate and 2,2-dichloropropionic acid. Dr. H. P. Allen (Plant Protection, Ltd.) described trials carried out in Malaya with phenyl-substituted ureas for the eradication of *lalang* (*Imperata cylindrica*). Neither 3(3,4-dichlorophenyl)-1,1-dimethyl urea nor 3(*p*-chlorophenyl)-1,1-dimethyl-urea resulted in complete control of this species unless the rates of application exceeded 80 lb. per acre. On the whole, better results were achieved when the treatment consisted of sodium trichloroacetate at 150–200 lb. per acre.

Prof. G. E. Blackman (Oxford) outlined the programme of investigations being conducted in East Africa by Dr. G. W. Ivens (Colonial Insecticide Research Unit, Tanganyika) in conjunction with the Agricultural Research Council's Unit at Oxford. The main object is to determine how far defoliants and arboricides can be used as means of eliminating tsetse flies through vegetation control. Experiments have shown that aircraft applications of the *n*-butyl ester of 2,4,5-trichlorophenoxyacetic acid are capable of defoliating, or even killing, a range of trees and shrubs found in communities which provide habitats for important species of tsetse fly. Besides applications from aircraft, other uses for such materials are being studied, and there is some evidence from Uganda that in high forest species of valueless trees can be eliminated by spraying the base of the tree with a suitable formulation of an arboricide, such as 2,4,5-trichlorophenoxyacetic acid.

FEDERATION OF MATHEMATICS AND PHYSICS SOCIETIES OF YUGOSLAVIA

CONGRESS IN ZAGREB

THE second congress of the Federation of Mathematics and Physics Societies of Yugoslavia was held in Zagreb during October 4–9, more than six hundred delegates attending. The congress considered a wide range of subjects—in the unanimous opinion of all present, too wide a range—indicating, among other matter, the growth of mathematics and physics in Yugoslavia. Some of the questions the congress examined were the teaching of mathematics and physics in secondary schools; the teaching at universities; and the organization of research in mathematics and physics. Eight sessions were devoted to research papers on mathematics, and nine to papers from the field of physics.

The present writer, being concerned mostly with nuclear physics, can give only a sample subject survey of papers in that field. One should bear in mind that this is the first time in the history of Yugoslavia that research papers in physics were reported at a nation-wide reunion of physicists. Altogether, a hundred and five research papers in physics were given, fifty-seven in the field of particle and nuclear physics, and forty-eight in optics, structure of crystals, geophysics, mathematical equipment, etc. A brief mention of the subjects of some of the papers in the field of nuclear and particle physics will indicate the range of interest. Theoretical research papers included one on the derivation of the nuclear forces from quantum field theory, one on the selection rules in meson theory and another two with Coulomb excitation of nuclei. Two communications dealt with the measurement of cosmic rays underground. A series of papers was on nuclear spectroscopy: beta decay of carbon-14, decay schemes of cæsium-133, cæsium-134, tungsten-185, etc. Other topics considered were the angular distribution in beryllium-9 reactions with deuterons, Auger spectrum of thorium B, the positive particles purported to be accompanying the beta decay of phosphorus-32, the duration of fission, etc. A number of papers dealt with neutron sources, neutron diffusion and calculations of distributions of neutron fluxes. The Stefan Institute of Ljubljana reported on the construction of a mass spectrograph, the Boshkovich Institute of Zagreb on the design of a cyclotron in the range of 20 MeV., and the Kidrich Institute of Belgrade on the functioning and improvement of the ion beam of a Cockcroft–Walton accelerator of 1·5 MeV.

At the final plenary session the congress adopted a series of decisions to be brought to the attention of the Yugoslav Government and the general public. Those pertaining to physics stressed the necessity of developing research in physics at the universities and urged greater material support of the Physics Department of the University of Belgrade. A systematic study was recommended for the development of physics in the country in the light of the development of its economy and the development of physics abroad. Especially underlined was the necessity for a more balanced development of physics research, with support for other branches of research in physics at least equal to that given to nuclear studies. There was considerable discussion, though no formal decision was taken, on the question of starting a central Yugoslav review of physics. At the congress an opinion was expressed that since physics in Yugoslavia is in the process of standing on its own feet, there should be, from an organization point of view, greater autonomy and independence of physics and mathematics activities in Yugoslavia. This point of view was reflected in the election of officers for the executive committee of the Federation, when Prof. G. Kurepa, a mathematician from Zagreb, was elected president, and Mr. A. Milojevich, a physicist from Belgrade, as secretary for physics.

STEVAN DEDIJER

ASSOCIATION OF SCHOOL NATURAL HISTORY SOCIETIES

ANNUAL EXHIBITION, 1954

THE annual exhibition of the Association of School Natural History Societies was held in London at the British Museum (Natural History) on November 6. The main contribution this year was made by member schools, one-third of which exhibited; this was a larger proportion than hitherto and resulted in the welcome criticism that the supply of bench space was too limited.

In spite of the lateness in the year, a wide variety of living material was exhibited. A collection of freshwater gastropods by Oundle School admirably illustrated the importance of accurate identification in limnological work. Bishop's Stortford College had reconstructed with living plants a quadrat from a derelict railway siding, and St. Paul's School, London, displayed living specimens to illustrate a genetical investigation of the shaker mutant in mice. Next year the London exhibition will be held in mid-October. It is hoped that this will encourage schools to produce even more living material.

Where it was impracticable to bring living specimens, most schools had brought preserved ones. University College School, London, filled a long bench with specimens illustrating the littoral biology of Skokholm, while Haileybury and Imperial Service College displayed a collection of the butterflies of France, made by present members of their Society. Lord Wandsworth College, Hampshire, showed a specimen of the water-beetle, *Agabus affinis*, which is a new record for the vice-county of North Hampshire. Further 'new records' were exhibited by naturalists of Kimbolton School who, in their survey of an overgrown Huntingdonshire orchard, have added seven new naturalized species, including *Anemone ranunculoides*, *Doronicum pardalianches*, *Tulipa sylvestris* and *Ornithogalum nutans*, to their county flora.

Many schools made good use of charts, diagrams and photographs to illustrate their work. Those exhibited by Bishop's Stortford College—on starling ringing, watches for visible migration and other ornithological problems—were exceptional for combining complexity with clarity, many being three-dimensional. Dulwich College and Reading School also provided well-documented accounts of their surveys. An interesting item was the 16-mm. colour film of the emergence, from the pupa, of a hornet clearwing moth, filmed by a member of Oundle School. Several schools demonstrated techniques which they had found useful, such as the plant-recording scheme shown by Uppingham School, and a method of mounting seaweeds demonstrated by Orange Hill Girls' Grammar School, Middlesex.

In addition to exhibits by member schools, there were displays by the Botanical Society of the British Isles, the British Naturalists' Association, the School Nature Study Union, the Universities Federation for Animal Welfare and several organizations connected with the British Museum (Natural History).

The increase in the number and size of exhibits received this year is an encouraging sign for the Association. Yet there are many members whose distance from London is such that they cannot attend. It is difficult for them, particularly if they are boarding schools, to arrange to bring a party to London; there is usually no possibility of being away from school overnight. For the benefit of its more distant members, the Association plans to hold an additional exhibition in Leicester next year. This should be within easy reach of schools situated in the Midlands and Northern England. O. N. Bishop

FINANCIAL EFFECT OF LABOUR TURNOVER

THE Research Board of the Faculty of Commerce and Social Science, University of Birmingham, has published a further monograph in its series of "Studies in Economics and Society", this latest being on "The Financial Effect of Labour Turnover", by Dr. F. T. Pearce*. The monograph, which is a mimeographed production, can be divided conveniently into three sections. The first section, of sixty pages, reviews many variants of the analytical definition of 'labour turnover' and its complement 'labour stability'. Not unnaturally, the author concludes that the definition adopted by the Birmingham School is to be preferred. This defines the rate of turnover as the number of employees who leave in a given period and have to be replaced expressed as a percentage of the average number employed during the period.

It should be pointed out that the rate so defined confuses current trends with the past economic fortunes of the employing company. A number of recent surveys (including one carried out by the Birmingham School) have established that the rate of labour wastage diminishes as length of service increases. If $F(t)$ is the proportion of an entrant group remaining in employment after t years service, if the rate of wastage $\varphi(t)$ is defined (by analogy with the demographer's 'force of mortality') by

$$\varphi(t) = -\frac{\mathrm{d}}{\mathrm{d}t}\{\log F(t)\},$$

and if n_j is the number of entrants into the firm during the year j, then the rate of labour turnover for the year x, to a first approximation, may be written:

$$\frac{\sum_t n_{x-t}\, F(t+\tfrac{1}{2})\, \varphi(t+\tfrac{1}{2})}{\sum_t n_{x-t}\, F(t+\tfrac{1}{2})}$$

Clearly the numbers n_{x-t} depend only upon past history and have no bearing upon current man-power problems. Equally clearly the formula will yield different rates of turnover for firms with identical rates of wastage but varying in their rates of growth or decay. This confusion of past and present makes it difficult to find any useful meaning for the calculated rate.

The second and largest section, which occupies the next hundred and ten pages, is an essay in accounting. A preliminary chapter outlines the theoretical approach and is followed by two detailed case studies. This section considers the effect on profits of the elimination of *all* labour wastage, and of all those extra charges which are incurred by management (for example, reserves of labour) in order to keep production flowing in spite of constant change in the labour force. A given output yields a gross profit margin of £P and requires N man-hours of 'direct' labour. If all workers had been experienced men, the same output would have required $N - l$ man-

* The Financial Effect of Labour Turnover. By Dr. Frank T. Pearce. (Monograph *A*.4 of the Research Board, Faculty of Commerce and Social Science, University of Birmingham.) Pp. 228; 1954. 15*s*.

hours. The difference is due to the lower output of recruits during their first 21 weeks of employment. The 'ineffective' l hours are a fraction $l/(N-l)$ of the notional 'effective' time worked. The consequential loss of profit is assumed to be $£Pl/(N-l)$. The computation of 'ineffective' time rests upon a comparison of the piece-work earnings of recruits and experienced workers. The additional cost of 'indirect' labour is also estimated.

The value of these painstaking case-studies is difficult to assess. The author has made a courageous attempt to provide a theoretical basis for his procedures, but the information he needs is just not available. Consequently, he is forced into numerous assumptions, particularly of linearity, that seem quite unreal. Moreover, the initial assumption of zero wastage is quite unattainable, except perhaps for isolated cases of very small concerns. Can it really be said that we are measuring the financial effect of labour turnover if we compare the actual outcome of a year's trading with what might have happened if the impossible had been achieved? The last, and shortest, section is an excellent summary of the remainder of the book.

H. SILCOCK

SWEATING MECHANISM IN THE DOMESTIC BUFFALO

By DR. E. S. E. HAFEZ and M. M. SHAFEI
Faculty of Agriculture, Cairo University

WATER evaporation from the surface of the skin is the major factor in thermal regulation in mammals. Water comes to the surface as insensible perspiration, which is a physical process, and as sensible perspiration or sweating, which is a physiological process affected by the microanatomy, histology and surface area of sweat glands, as well as the blood and nerve supply of the gland.

We have investigated, by histological methods, the sweating mechanism in the domestic buffalo. Skin specimens from sixteen different regions of the body of three adult male buffaloes have been examined. Bouin's fluid was used for fixation and terpineol for clearing. Embedding was carried out under a vacuum of 67 cm. mercury using paraffin wax (m.p. 50° C.). Serial sections were cut at 25 μ and stained by Delafield's hæmatoxylin and 1 per cent aqueous eosin.

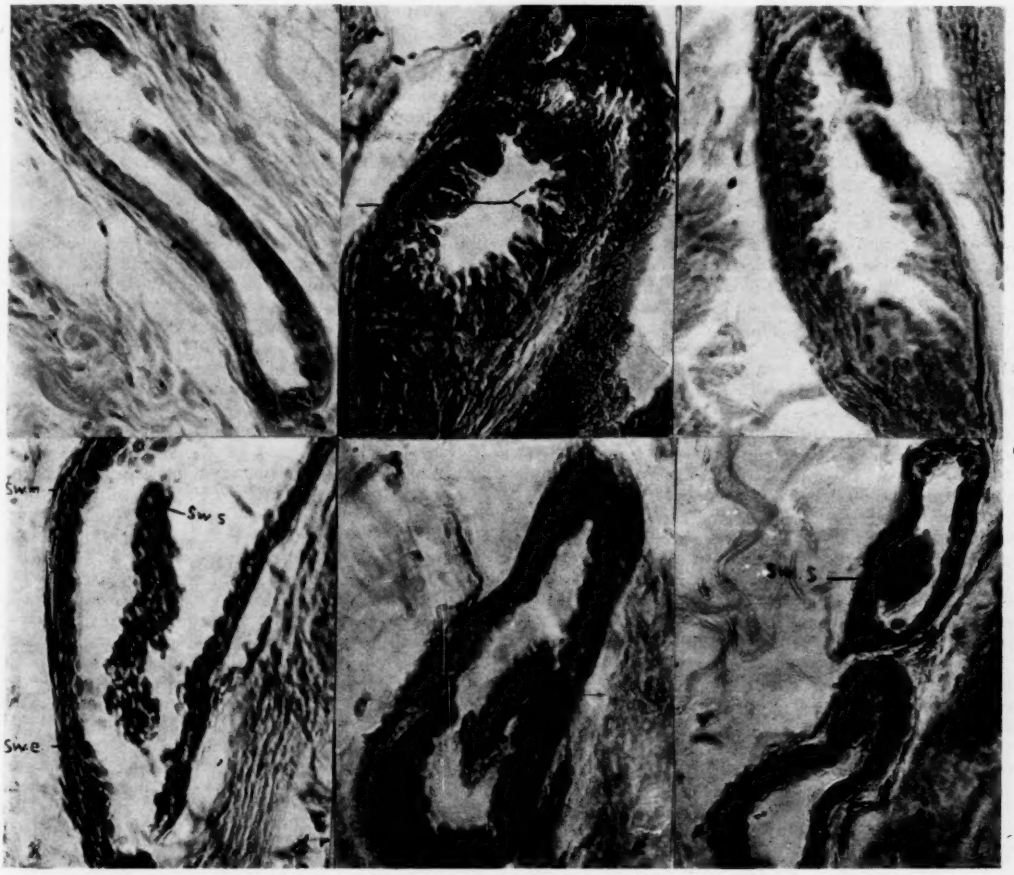

Fig. 1. Successive stages in the formation and intraluminal transformation process of the secretion of sweat glands in the buffalo (× 250)

(*a*) First formation of the cytoplasmic protrusions from the glandular epithelial cells
(*b*) Globular protrusions attached to the cells
(*c*) Chains of the globular protrusions
(*d*) Detached globules aggregated in the lumen
(*e*) Fusion of the globules
(*f*) A gel-like homogeneous material; note that the glandular epithelium is similar to (*a*)

Fig. 2. Simple form of sweat glands in buffaloes (× 250). The glandular epithelium is composed of cubical or flattened cells with small nuclei. The material inside the gland consists of fine granules

In the buffalo, the body of the sweat gland is oval and convoluted, and the duct is twisted at its attachment to the body. The blood supply of the gland is very poor. The body wall is composed of two structures: an outer myoepithelium and an inner layer of glandular epithelium. The gland showed two types of active cells. In the first, a typical apocrine type, the glandular epithelium was made up of columnar epithelial cells with spherical nuclei and cytoplasmic protrusions at the apical portion. The lumen of the gland contained a stainable material which varied in form from separate globular pieces to homogeneous gel-like regions (Fig. 1). In the second type, the glandular epithelial cells were cubical or flattened, with small nuclei, the gland lumen was often empty and some glands contained a fine precipitated substance (Fig. 2).

Both types of glands were observed in the same section of skin and the apocrine form predominated. It would appear that the apocrine glands in the buffalo have only one phase in different stages, and that this stage of secretion is merely preparatory to the ensuing phase. The hypothesis of intraluminal transformation from coarse granules to a fluid-like substance[1] is thus supported. The microanatomy of the sweat gland may be involved in determining the form of secreted substance and may affect the expulsion of sweat. In the buffalo, the twisted duct delays the emptying of the sacular body; this may induce a back pressure which interferes with the elaboration of sweat substance.

Further work is needed to correlate these histological findings with the physiological background of the sweating mechanism. The chloride concentration in bovine skin will be important in determining the nature of insensible perspiration often observed in certain body regions such as the base of the ear, lateral and ventral neck, axilla and groin. Geographical locality of the animal will probably also affect the sweating mechanism.

This work was carried out at the Animal Breeding Research Farm and the Agricultural Zoology Department, Cairo. Thanks are due to Prof. A. L. Badreldin for his encouragement and suggestions. Work is still in progress and detailed results will appear elsewhere. [Aug. 2.

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DIGESTIBILITY OF A SAMPLE OF PASTURE GRASS BY CALVES

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THE possibility of rearing calves on pasture grass from an early age has recently received a considerable amount of attention in Great Britain. The method, which possesses certain economic advantages, has been common practice in New Zealand for a number of years.

Relatively little information exists concerning the utilization of grass by calves. Conrad and co-workers[1], in a study of the effect of rumen inoculations on the digestibility of roughage by young calves, determined the digestibility of lawn clippings, and one of us (Preston, unpublished results) has obtained preliminary figures using fæcal index techniques with the grazing animal. In view of the limited observations available and the need for confirming coefficients of digestibility obtained by fæcal index methods, it was decided to determine the digestibility of a sample of pasture grass by calves aged 10–12 weeks. To allow for the material being fed in the fresh condition, the cold-storage technique developed by Raymond *et al.*[2] was used.

A uniform sample of herbage from a long-established ley was cut on May 25 at the pre-flowering stage. Botanical analysis showed it to contain 91·9 per cent of grass and 5·7 per cent of clover. Accurately weighed quantities of the herbage (15 lb. or 20 lb.) were placed in sacks, which were immediately frozen and cold-stored at 0–5° F. The above amounts were estimated to provide a daily intake of 3 lb. or of 4 lb. of dry matter. As every ten sacks were filled, a 200-gm. sample was taken for dry-matter determination and for the provision of a representative sample.

Four unrelated Ayrshire male calves each reared from birth on pasture, and 34 gal. of milk were put into metabolism crates at the age of nine weeks. Fæces were collected in rubber bags, the bags and harness being based upon a design supplied by Dr. K. L. Blaxter. During the experimental period, which comprised a 10-day preliminary and a 10-day collection period, each animal received the contents of one sack of herbage daily. Calves 1, 3 and 4 were fed 15-lb. quantities; calf 2, by reason of its greater live weight, was fed 20 lb. Feeding times were 9.0 a.m., 11.30 a.m., 2.30 p.m. and 5.0 p.m. With the first and last feed of each day, a gelatine capsule containing 2 gm. chromium oxide (Cr_2O_3) was given. When first fed the frozen grass, calf 3 scoured badly, but quickly recovered following the administration of 20 mgm. of aureomycin on three consecutive days. The remaining calves were dosed simultaneously.

The large weights of fæces voided necessitated the bags being changed twice daily. The weights of fæces were determined by weighing the bags prior to, and immediately after, use. After the contents of each bag had been thoroughly mixed, duplicate 80–100 gm. samples for dry matter were weighed on to tared pieces of grease-proofed paper and thinly spread by means of a spatula to ensure efficient drying. The papers were dried to constant weight in a 'Unitherm' oven at 100° C. Using this technique, agreement between duplicates was invariably excellent. Aliquots of the fresh fæces (10 per cent by weight) were transferred to waxed cartons and kept in cold storage until the end of the trial, when they were bulked to provide representative samples.

The representative samples of wet fæces were treated as follows: 150 gm. was intimately mixed with approximately 100 gm. water in a 'Magimix' blendor, and accurately weighed quantities of the resulting suspension were analysed for dry matter, nitrogen and 'macerate crude fibre'[2]. The remainders of the bulked samples were oven-dried at 60° C. for 48 hr., ground and afterwards analysed for residual moisture, ash, ether extract and crude fibre, by the conventional methods. All samples were further analysed for lignin by the method of Norman and Jenkins as modified by Common[4], and for cellulose by the method of Norman and Jenkins[5]. Chromium oxide was determined according to the procedure of Schürch, Lloyd and Crampton[6].

Table 1. Analysis of Grass and the Digestibility Coefficients determined for Calves

	Analysis of feed (per cent of dry matter)	Digestibility coefficients				
		Calf 1	Calf 2	Calf 3	Calf 4	Mean
Dry matter	—	74·6	74·5	78·5	72·4	75·0
Organic matter	92·76	76·6	76·9	80·5	74·5	77·1
Crude protein	13·57	60·1	58·9	65·7	54·5	59·8
Ether extractives	3·69	44·0	43·3	52·9	42·2	45·6
Crude fibre	25·41	78·7	79·9	82·9	77·3	79·7
Nitrogen-free extractives (by difference)	50·09	82·5	82·8	85·3	80·9	82·9
Cellulose	35·22	83·2	85·4	87·7	79·8	84·0
Lignin	3·79	2·1	−7·1	14·7	2·4	3·0

The analysis of the grass and the digestibility coefficients determined are shown in Table 1. While, in general, the digestibility coefficients for calves 1, 2 and 4 show satisfactory agreement, the values obtained for calf 3 are consistently higher. The high digestibility of the organic matter and of the cellulose fraction in particular, and the relatively low value for the apparent digestibility of protein, are noteworthy features of the results. Lignin is clearly almost indigestible.

Table 2. Chromium Oxide Recovery

Weight fed (gm.)	Weight recovered in fæces (gm.)				Mean percentage recovery
	Calf 1	Calf 2	Calf 3	Calf 4	
40·00*	41·10	40·78	38·99	42·79	102·30±1·93

* The capsules were guaranteed to contain 2 gm. chromium oxide with a maximum variance of 3 per cent.

From the results shown in Table 2, it can be seen that, with perhaps the exception of calf 4, the recovery of chromium oxide in the fæces has been very satisfactory.

It has already been noted that only one of the calves (calf 2) received the higher intake of 20 lb. a day throughout the experimental period. Before the conclusion of the collection period, calf 3 was clearly capable of eating more than the 15 lb. offered. That this underfeeding may have been responsible for the more efficient digestion of the grass by this animal is suggested by the work of Mitchell *et al.*[7], who, in experiments with steers, showed that the digestibility of dry matter in a ration increased as the level of feed was reduced.

Perhaps the outstanding feature of the results is the very high digestibility of dry matter in the fresh herbage. The coefficients of digestibility for cellulose are even higher. Figures of this magnitude can only reflect an advanced development of the rumen, which is surprising considering the age of the calves. It will be recalled, however, that the calves had been reared on grass from birth, during which period live-weight gains of up to 1 lb. a day were made, and certainly their appearance denoted good paunch development. It should be added that similar values for dry matter and cellulose digestibility, namely, 72·0 per cent and 82·0 per cent, were obtained by Conrad *et al.*[1] during the course of feeding freshly cut lawn clippings to nine-week old calves.

The relatively low apparent digestibility of the protein is difficult to account for in view of the high coefficients obtained for dry matter. It may be that they result from the excretion of considerable quantities of metabolic nitrogen in the fæces. Blaxter and Wood[8] have quoted a value of 2 gm. metabolic fæcal nitrogen per 100 gm. dry matter excreted, for very young calves; and if this factor is used to correct the values for nitrogen excretion, the mean true digestibility coefficient of the protein is found to be 82·9 per cent.

The satisfactory recovery of chromium oxide obtained in this instance would appear to justify the use of this substance as a reference material for indirect digestibility studies with calves.

In studies on the digestibility of herbage, Raymond *et al.*[9] have calculated a regression equation for sheep which relates organic matter digestibility with (1) macerate crude fibre content in fæces ($y = 93{\cdot}42 - 0{\cdot}6582\,u$, where y is digestibility of organic matter and u is per cent macerate crude fibre in fæces on an organic matter basis), and (2) nitrogen in fæces ($y = 44{\cdot}85 + 7{\cdot}947\,v$, where v is per cent nitrogen in fæces on an organic matter basis). Applying regressions 1 and 2 to the results obtained in the present experiment, the mean calculated digestibility coefficients for organic matter are 78·69 and 77·56, respectively. These values compare favourably with the determined value, namely, 77·14. While further confirmatory evidence is needed, these results would suggest the possibility of using the above regressions in digestibility studies with calves at pasture.

We wish to thank Mr. G. A. Cragghill for his assistance in the investigation. [Sept. 24.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Direction of Polarization of Proton Spin produced by Elastic Scattering

Beams of high-energy protons with spin polarization are produced by scattering unpolarized protons from nuclei[1,2]. If the protons are scattered elastically, the polarization is considerably larger than if the scattering occurs by inelastic processes[3,4]. A theoretical interpretation has been suggested by Fermi and others[5], which demonstrates that the polarization of the elastically scattered beam may be accounted for as a consequence of the spin orbit-coupling postulated in the nuclear shell model of Mayer and Jensen. This hypothesis gives correctly the magnitude of the observed polarization, and in addition predicts the direction of the polarization. In particular, if the scattering is to the right at small angles, this hypothesis requires the predominant spin direction to be downward.

The object of the present experiment was to measure the direction of the polarization, a property impossible to determine by the usual double-scattering experiments. The measurement depended on knowledge of the polarization resulting from interference of the energy-levels involved in the elastic scattering of protons on helium in the energy region 1–15 MeV. From the cross-section data for this reaction, Critchfield and Dodder[6] have evaluated the phase shifts. In fact, two representations of the data were found, for both of which the ^3P phase shifts were positive (attractive potential). In one solution the ^3P-states were inverted, and in the other solution they were normal. Interference of the states of the doublet produces a polarization of the scattered protons. Heusinkveld and Freier[7] observed the second scattering asymmetry resulting from this polarization, and by its magnitude at a given energy were able to conclude that the P-state is an inverted doublet.

This information allows one in principle to determine the spin direction of a beam of polarized protons by a similar experiment.

In the present investigation, a 435-MeV. 60 per cent polarized proton beam was produced in the cyclotron by scattering elastically the circulating protons of 450 MeV. maximum energy at 14° from an internal beryllium target. The polarization of the emergent proton beam was determined in the usual way, by measuring the asymmetry of elastic scattering from beryllium at the same angle, namely, 14°. Then the protons were slowed down by passing through a thickness of copper approximately equal to their mean range, after which they were expected still to be polarized[8]. The protons of various low energies in the region 0–20 MeV. were then collimated carefully. Next they entered a scattering chamber filled with helium at atmospheric pressure (see Fig. 1). Nuclear emulsions (Ilford *E*1) were placed to right and left in the scattering chamber in such a way that protons scattered by the collimating system could not reach them, and in such a way that protons scattered in the horizontal plane by helium and at ± 90° to the beam entered the emulsion in a direction normal to the surface.

There were approximately 30,000 high-energy protons arriving per second at the copper attenuator. The flux, however, was drastically reduced by scattering during energy degradation and subsequent collimation. The frequency of occurrence of events in the plates is found to be in rough agreement with the estimated slow-proton flux and with the elastic scattering cross-section of helium.

From the direction in which a scattered proton enters the emulsion and from its energy as determined by its range in the emulsion, one computes the energy of the proton before scattering. Only those events are accepted for measurement in which the proton enters the emulsion within 45° of the normal to the surface of the emulsion. At present, approximately fifty events have been found. In Fig. 2 the number of events is plotted against the incident energy computed for the scattered proton.

For comparison purposes we have calculated the helium cross-sections for a proton beam polarized with spin down, for scattering to right and to left, as a function of energy and angle using the phase shifts at present available[6,9]. The differential cross-sections have been integrated over the solid angle of

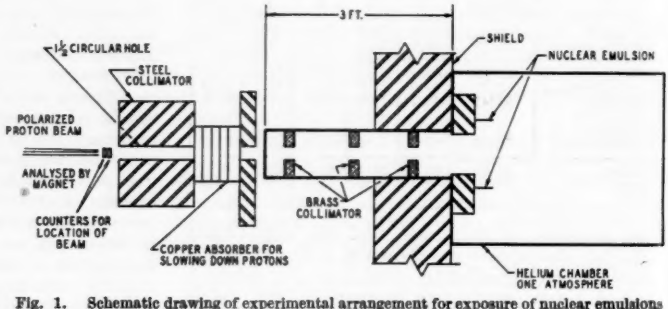

Fig. 1. Schematic drawing of experimental arrangement for exposure of nuclear emulsions to energy-attenuated polarized beam

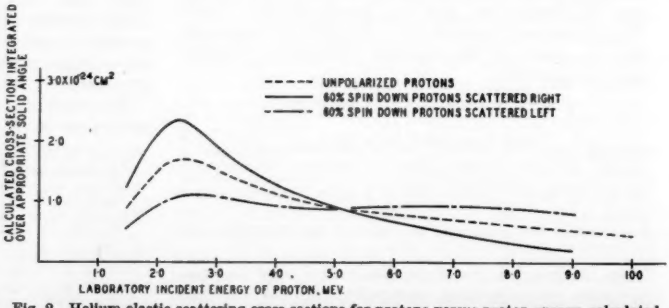

Fig. 2. Helium elastic scattering cross-sections for protons versus proton energy, calculated from phase shifts, and integrated over solid angle in which scattering events were accepted. The cross-section for unpolarized protons scattered either to left or right is shown, and also the cross-sections for protons 60 per cent polarized with spin down, scattered to left and to right. For the case of protons 60 per cent polarized with spin up, the designations on the two latter curves are interchanged

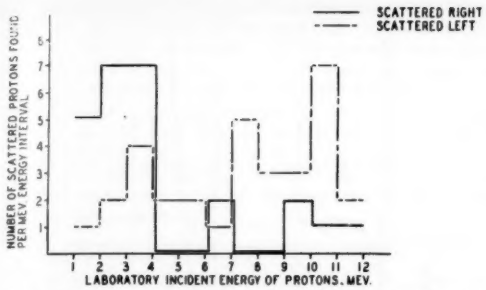
SCATTERED RIGHT
SCATTERED LEFT
NUMBER OF SCATTERED PROTONS FOUND PER MEV ENERGY INTERVAL
LABORATORY INCIDENT ENERGY OF PROTONS. MEV.

Fig. 3. Number of polarized protons observed to be scattered to left and to right between $\theta = \pm 45°$ and $\theta = \pm 135°$ laboratory angle shown plotted versus energy of incident proton

acceptance and corrected for the fact that the incident beam is 60 per cent polarized. The resultant cross-sections, plotted in Fig. 3, show right scattering stronger than left scattering near 3 MeV., and at 7–11 MeV. right scattering weaker than left scattering. If, on the other hand, the incident beam were assumed polarized with spin up, the cross-sections in Fig. 3 for scattering to the left and right would be interchanged.

The results in Fig. 2 show, however, a behaviour similar to the curves of Fig. 3, within the large statistical errors. Consequently we reach the tentative conclusion that the proton beam incident on the helium is polarized with spin down.

We now return to a consideration of the first scattering which produced the polarized beam. The first scattering, in the cyclotron, was to the right, for which, for an attractive potential, $\vec{L}$ is directed downward.

But the tentative conclusion allowed by the foregoing evidence is that the spin of the right scattered beam is downward, that is, parallel to $\vec{L}$. Then the elastic scattering is stronger at small angles for spin parallel to $\vec{L}$, in agreement with the proposal[8] that the polarization is due to the spin orbit-coupling effective in nuclear shell structure.

We hope to publish soon a more detailed discussion of this experiment, including better statistics of the scattering events. We are grateful to Robert March for help in plate scanning, and to Dr. Frank Solmitz, who helped in the calculation of the cross-sections in Fig. 2.

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Chemisorption on Metals

The criterion for chemisorption on metals is the occurrence of an electron switch, the resulting complex having a dipole moment orientated vertically to the surface. The method of contact potentials has been employed to evaluate the magnitude of the change in work function of the surface as a result of chemisorption, and recently the vibrating condenser method has been used for the same purpose. There are some disadvantages attached to these methods. In the former, thermal radiation from the emitter may alter the composition of the chemisorbed layer on the cold surface; in the latter, the presence of a large amount of metal and the assumption that only parts of the system are affected by the introduction of the gas militate against the exact determination of the dipole-moment surface-coverage (μ,θ) relationship.

We have recently explored the potentialities inherent in the determination of this relationship by photoelectric methods. The method consists essentially in measuring the photo-current produced on illumination of a freshly formed metallic mirror with ultra-violet light of suitable wave-lengths transmitted through a quartz window. From the adsorption isotherms it is possible to evaluate the coverage as a function of dosage and to make simultaneous measurements of the photo-currents. Some values for the change in work-function potential are given for $\theta = 1$ in Table 1.

Table 1

Surface potential in volts	Ta—H	Ta—CO	Fe—H	Fe—CO	Co—H	Co—CO	Ni—H
	−0·43	−0·67	−0·19	−1·15	−0·06	−0·27	−0·12

Of great interest is the fact that the curve of dV against surface coverage (θ) is not linear over the whole range of coverage but shows a curvature at the commencement. In addition, as seen from Fig. 1, when θ is equal to or greater than 0·6, there is a falling off in the value of the apparent dipole moment, thus providing additional support to the view, based upon experimental determination of the adsorption isotherms and on heats of adsorption, that at least in many cases of chemisorption the bond-strength between adsorbate and adsorbent is not constant but changes as the electron density in the

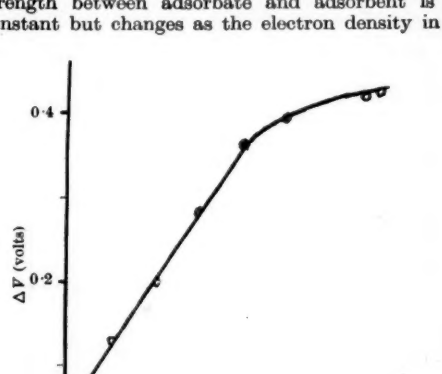

Fig. 1. Variation of surface potential with surface coverage (hydrogen adsorption on tantalum)

metal surface undergoes changes as a result of chemisorption.

It is hoped to publish a more detailed account of the method shortly.

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Transition Temperature of Polymethyl Methacrylate at Ultrasonic Frequencies

Pulse method measurements by Krishnamurthi and Sastry[1] and Melchor and Petrauskas[2], of the variation of ultrasonic velocities with temperature for polymethyl methacrylate ('Perspex'), showed that the transition temperature was independent of frequency (0·5–10 Mc./s.). Protzman[3], using an optical diffraction method, found that the transition point for 'Plexiglas II' (unplasticized 'Perspex') varied from 63° C. at 3 Mc./s. to 49° C. at 11 Mc./s. The authors claim an accuracy of ± 1 per cent for their results, which are shown in Fig. 1, together with some of my own results. The following comments are made on these results.

(*a*) Results on different samples of commercial plastic materials are likely to vary. This has recently been pointed out in low-frequency work on polymethyl methacrylate by Deutsch, Hoff and Reddish[4]. Heating may also cause irreversible changes in plastic materials.

(*b*) Protzman's[3] velocity results differ from Melchor's[2] by a maximum of 6 per cent, the agreement being good at room temperature. One possible error in Protzman's[3] work is that several watts of ultrasonic energy could have been transmitted into the sample. This would cause internal heating, and

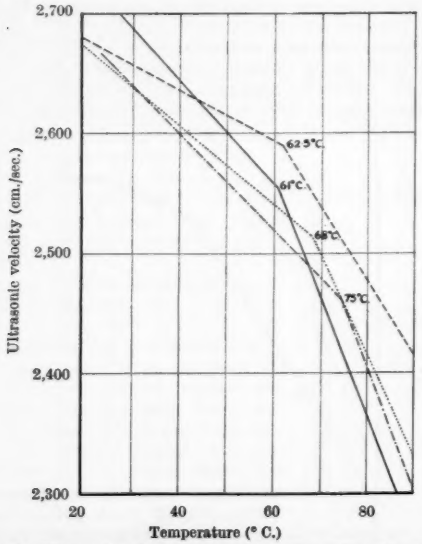

Fig. 1. Ultrasonic velocity – temperature curves for polymethy methacrylate. — — —, Protzman's results at 3 Mc./s., frequency-dependent; . . . . . , Hatfield's results at 350–750 kc./s.; —·—·—, Melchor and Petrauskas's results at 0·5–10 Mc./s.; ———, Krishnamurthi and Sastry's results at 1–6 Mc./s.

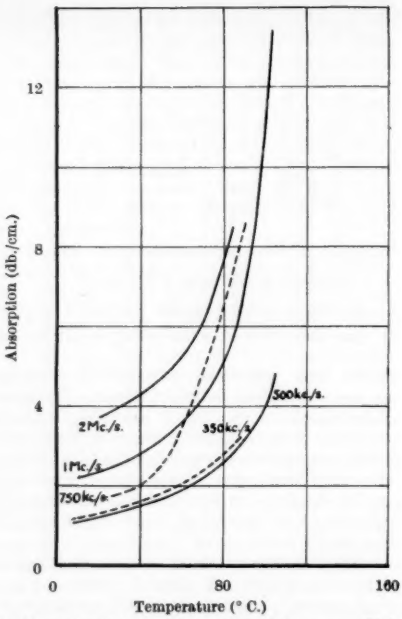

Fig. 2. Absorption in polymethyl methacrylate. ———, Melchor's results; – – – –, Hatfield's results

the observed temperature in the surrounding liquid would not be the true sample temperature. Protzman does not state the energy used, but he mentions that 500–1,000 volts (radio-frequency) were applied to the quartz crystal. This is much higher than is usual. This internal heating would be dependent on frequency and could cause the variation of transition temperature with frequency. A further possible error, if the transducer was small and high energy was used, may have been that ultrasonic waves were transmitted into the oil-bath from the sample. If this occurred, then the light beam would have been diffracted in the liquid as well as the solid. Willard[5], using an improved optical diffraction method for plastics, allows a parallel ultrasonic beam to be transmitted into the solid and surrounding liquid medium. He then corrects his velocity results for the variations in velocity of sound in the liquid with temperature.

(*c*) The slopes of the curves obtained by Krishnamurthi[1] and Melchor[2] are similar, but the transition temperatures differ by approximately 14° C. Melchor points out that the determination of this transition temperature to within a few degrees is not easy because of the high absorption of polymethyl methacrylate, at temperatures above 60° C. and frequencies greater than 1 Mc./s. Fig. 2 shows results obtained by Melchor and myself (accuracy ± 1 db.) for the variation of absorption with temperature at frequencies less than 2 Mc./s.

(*d*) The pulse method has been greatly improved by Mason[6], and it would be interesting to repeat the pulse experiments on polymethyl methacrylate using this method.

(*e*) Fig. 1 shows my velocity measurements for polymethyl methacrylate plotted against temperature at frequencies less than 1 Mc./s. These results were obtained using a low-power (less than 1 watt) continuous-wave phase method[7]. The absolute accuracy

of this method is not as good as the attainable accuracy of the optical diffraction or pulse method, particularly for materials the acoustic impedances of which differ appreciably from those for water or oil, but the low absorption at high temperatures at less than 1 Mc./s. is not a source of error. The velocity results at 350 and 750 kc./s. are not significantly different, and the transition temperature over a series of runs varied between 66° and 71° C. These results are similar to those obtained by Melchor[2] and by Krishnamurthi[1].

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Low-temperature Sintering of Titanium Dioxide for Ceramic Capacitors

THE investigations carried out by Berberich[1], Von Hippel[2] and Wainer[3] and their associates on titanium dioxide point to certain optimum firing conditions. In particular, a temperature of 1,350° C. is found to be suitable for obtaining most of the desirable electrical characteristics. Among these characteristics may be specially mentioned low water absorption, high permittivity, high insulation resistance and low loss-angle. From the known values of the two principal permittivities of the single crystal of rutile, the permittivity for randomly oriented powdered rutile would be about 114. The values of the permittivity reported in the literature vary from 96 to 100, and water absorption is known to be about 0·1 per cent. The rutile form of titanium dioxide used in their experiments was prepared by calcining commercial quality titanium dioxide, probably of the anantase type, at 1,350° C.

In some large-scale experiments carried out at the National Physical Laboratory of India on a particular brand of commercial quality of titanium dioxide bearing the trade name "Rutiox CR" (Kronos), it has been possible to obtain ceramic bodies with excellent dielectric properties when fired at temperatures as low as 1,100° C. in electric furnaces. It was not found necessary to calcine the material first, and a straight firing schedule was adopted which gave well-sintered bodies. The neutral atmosphere of the electric furnace and the partially reducing atmosphere of a gas furnace gave identical results. It was also found that the sintering temperatures were not very critical, as reported by earlier investigators. Satisfactory bodies could be obtained when fired over a range of temperatures from 1,100° to 1,400° C.

X-ray diffraction studies and the density measurements showed that the raw material was of the rutile crystalline form. Measurements by microscope of particle-size indicated sizes generally in the range 1–5 microns, with crystal edges sharp, indicating that the titanium dioxide was perhaps manufactured in these particle sizes, by chemical processes and not by grinding calcined material.

Some typical values obtained with bodies prepared as stated above are: water absorption, 0·01 per cent; permittivity, 110.

It would appear that the low sintering temperatures, coupled with good electrical properties, are due to the rutile crystalline form and the finely divided active state of the titanium dioxide used.

Fuller details of the experiments will be reported elsewhere. We are indebted to Sir K. S. Krishnan for his advice and guidance.

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New Delhi, 12.
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Polymerization Reactions occurring during Dinitrophenylation of α-, β- and ω-Amino-acids with Sanger's Reagent

NUMEROUS papers have been published concerning the identification and determination of amino-acids by the dinitrophenylation method introduced by Sanger[1]. We are not aware, however, of any indications in the literature about the occurrence of polymerization reactions during dinitrophenylation. In an attempt to work out a procedure for the quantitative determination of minute amounts of ε-aminocaproic acid and its linear oligomers, we have found that such polymerization reactions do occur. Similar results have been found during dinitrophenylation of other ω-amino-acids and of glycine and β-alanine. Since these side-reactions may lead to complications in investigations on the separation and determination of dinitrophenyl amino-acids in general, it seems useful to communicate these facts briefly.

Dinitrophenylations were carried out by Sanger's method[1], using 1-fluoro-2,4-dinitrobenzene in aqueous ethanol in the presence of sodium bicarbonate. Isolated products as well as samples of reaction mixtures were analysed by chromatography on paper strips using a descending technique (see Table 1). Since pure ε-aminocaproic acid and the nearly pure synthetic dimer and trimer of the acid[2] were at our disposal, chromatographic spots of the corresponding dinitrophenyl derivatives could be easily identified. With the eluent used, R_F-values decrease with increasing molecular weight (Table 1). The purity of our samples of aminocaproic acid was checked by chromatography of aminocaproic acid as such (method worked out by van der Want[3], slightly modified).

From a mixture of initial composition 0·75 m.mol. ε-aminocaproic acid, about an equimolecular amount of fluorodinitrobenzene and 1·6 m.mol. sodium bicarbonate in 10 ml. aqueous ethanol (25 per cent of water), reacting at room temperature, samples were taken at successive intervals. Each sample served to place ten spots (of 10 μl. each) on a chromatographic strip. Depending upon the duration of reaction, one or more additional spots appeared on the eluted chromatograms besides the expected spot of dinitrophenyl–aminocaproic acid. From their R_F-values relative to that of the latter, these spots could be identified as the dimer, trimer and so on.

Table 1. Polymerization Products produced during Dinitrophenylation of the Monomers and their Relative R_F-values (R_F-values of the corresponding Dinitrophenyl-monomers taken as Unity)

Chromatography on Whatman No. 1 paper (soaked in 0·1 *M* citric acid and dried in air) with a mixture of *n*-propanol (diluted with water to spec. gr. 0·813), glacial acetic acid (containing 1·5 per cent of water) and kerosene (b.p. 100–140° C.) in the volume proportions 20 : 6 : 100

ω-Amino-undecanoic acid	ω-Amino-heptanoic acid	ε-Amino-caproic acid	β-Alanine	Glycine	Dinitrophenyl-
1	1	1	1	1	monomer
0·50	0·48	0·46	0·37	0·39	dimer
0·33	0·31	0·27	0·23	0·12	trimer
—	0·16	0·17	0·11	—	tetramer
—	—	0·10*	—	—	pentamer

* Only found once in a dinitrophenyl-aminocaproic acid sample synthesized by a method not mentioned in this communication.

This proves that polymerization occurs during the dinitrophenylation reaction.

Mixing the reagents and reaction products (including the products of other side-reactions known to occur, like dinitrophenol, dinitrophenetol) in various combinations and examining the products eventually obtained, we found that at least the components fluorodinitrobenzene, aminocaproic acid (and dinitrophenyl–aminocaproic acid) must be present to produce polymerization.

As pointed out recently by Bunnet and Davis[3] and by Zahn and Kockläuner[4], dinitrophenyl halogenides behave as acid halogenides in many respects. Frankel, Liwschitz and Zilkha[5] have found that acetyl chloride can produce polymerization of amino-acids even at room temperature. It seems that fluorodinitrobenzene can give rise to analogous reactions.

Other amino-acids such as ω-aminoheptanoic acid, ω-amino-undecanoic acid, β-alanine and glycine also show some polymerization when dinitrophenylated by the method described above.

In the dinitrophenylation of aminocaproic acid with reaction times from 1 to 120 hr., the proportion of the dimer to the dinitrophenyl–aminocaproic acid varied from about 2 to 20 mol. per cent (also depending upon the water content of the mixture). After 120 hr., only about 40–50 per cent of the expected quantity of dinitrophenyl–aminocaproic acid was present, and total conversion of ε-aminocaproic acid into the dinitrophenyl compounds was about 60 per cent. This was established by elution of the spots from the paper, followed by ultra-violet light absorption measurements.

More complete conversion of aminocaproic acid into dinitrophenyl–aminocaproic acid and its oligomers was achieved only after evaporation of the reaction mixture until dry at elevated temperatures. This is in agreement with the work of Schroeder and Le Gette[6], who reported that conversion is enhanced by raising the concentration of the amino-acid in the reaction mixture.

From the other amino-acids we have not measured the proportions of the polymerization products, but from the intensity of the spots on the chromatograms it can be estimated that the proportion of dinitrophenyl–amino-acid dimer found under equal reaction conditions is in the following order of increasing magnitude:

Glycine $\ll$ β-alanine $<$ ε-aminocaproic acid $\sim$ ω-aminoheptanoic acid $\sim$ ω-amino-undecanoic acid.

Since dinitrophenyl–glycine dimer formation is very small, this may also pertain to other α-amino-acids and may explain the favourable results achieved by Mills[7] for glycine, aspartic and glutamic acid. Nevertheless, certain losses in quantitative dinitrophenylation experiments with α-amino-acids may be due to polymerization, and the occurrence of parasite spots on the chromatograms would then also be accounted for.

Table 1 gives a review of the relative R_F-values of the dinitrophenyl oligomers of the various amino-acids.

We are indebted to Dr. G. M. van der Want[2] (Delft) for supplying the samples of ε-aminocaproic acid dimer and trimer, and to Dr. H. Zahn (Heidelberg) for a supply of fluorodinitrobenzene. Grateful acknowledgment is made to Mr. F. Woutman (Arnhem) for carrying out the ultra-violet extinction measurements and to Miss E. A. Smit for performing the numerous experiments. This work has arisen from a programme of fundamental research on polyamides carried out in co-operation with the Plastic Research Institute T.N.O., Delft, and sponsored by AKU (General Rayon Union), Arnhem, and Netherlands State Mines, Geleen.

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Alternation in the Adsorption of Aliphatic Acids on Porous Carbon

Alternation in many of the properties of successive members in homologous series of solid long-chain compounds is well known. We are reporting the direct observation of a similar alternation in the maximum adsorptions of mono-[1] and di-carboxylic acids from aqueous solutions on two series of coconut shell charcoals of different degrees of activation. Some alternation in the adsorptions of these acids on a single 'Norite' charcoal was found indirectly by Linner and Gortner[2], who made a Langmuir extrapolation of their isotherms to maximum adsorption.

In the present work the adsorptions were measured by the change-in-titre method. The results for a more activated charcoal are given in Fig. 1. As the activity[1] of the charcoals decreased, the degree of alternation in adsorption decreased. In the case of the mono-acids, alternation disappeared entirely for the lesser activated charcoals; apparently it was masked by molecular sieving.

The alternation in adsorption is compared with the alternation in melting points of the acids in Fig. 1. The scales for the two acid series were displaced so that each series would appear separately. The arbitrary elements in the graph are the temperature and adsorption scales themselves, and the approximate overlapping of the melting point and the adsorption of one of the acids in each acid series. The results suggest that there is a close correlation

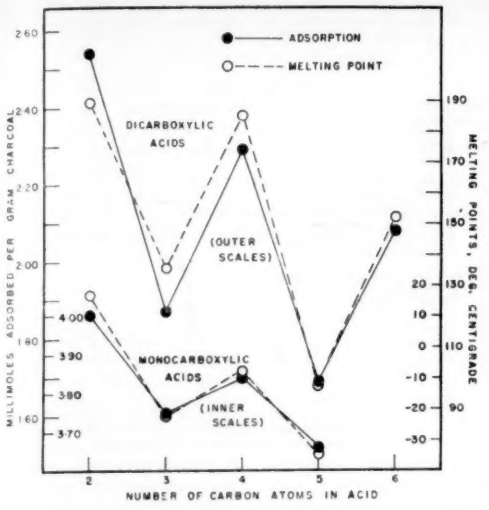

Fig. 1

between the alternations in melting points and adsorptions. Thus it would appear that the saturated adsorbed film is in a highly oriented state such as in crystalline solids.

We believe that an explanation for the alternation in the case of adsorption must be looked for in differences in lateral packing rather than in the lengths of the chains[3]. Moreover, our observations tend to refute the suggestion that adsorption from binary mixtures on porous adsorbents is always by a pore-filling mechanism[4]. Rather, they strongly suggest that adsorption of the aliphatic acids from aqueous solutions on porous carbons is in unimolecular layers.

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Identification of an Artefact on Chromatograms of the Keto-acid 2,4-Dinitrophenylhydrazones

DURING a study of plant keto-acids carried out by one of us (G. H. N. T.) under the direction of Prof. F. C. Steward at Cornell University, an unknown substance, hereafter designated compound I, was found in the keto-acid fraction of all plant tissues examined[1]. This substance was isolated in crystalline form (sint. 206°, decomp. 214°) from the keto-acid dinitrophenylhydrazone fraction of *Mentha piperita* leaves by elution from an alumina column with 1 per cent sodium carbonate. Its position on chromatograms was similar to that of the slower-moving spot of pyruvic acid dinitrophenylhydrazone (Fig. 1, ref. 1). The pyruvic acid spot developed a chocolate colour when sprayed with alkali, whereas compound I gave a yellow colour. On hydrogenation, compound I yielded a ninhydrin-reactive substance (compound II) which was chromatographically similar to γ-aminobutyric acid (Fig. 2, ref. 1). The infra-red absorption spectrum of compound I did not display the carboxyl peak characteristic of α-keto-acid dinitrophenylhydrazoness.

We have utilized the same procedures[1] for a study of the relation between the keto-acids and the fixation of carbon-14 dioxide in leaves. Compound I consistently recurred on chromatograms of the keto-acid dinitrophenylhydrazoness. Although under favourable conditions radiocarbon was incorporated by the leaf into most of the recognized keto-acids, it never entered compound I. We therefore suspected that it might be an artefact.

When the reagent (2,4-dinitrophenylhydrazine) was dissolved in ethyl acetate and extracted with alkali in the manner used in the keto-acid method, a brown gum was recovered from the alkaline extract. Chromatograms of this gum showed two main spots: one, a fast-moving brown spot; the other, identical in position with compound I. Alkali-extracted and recrystallized 2,4-dinitrophenylhydrazine still gave these substances on a second extraction with alkali.

A survey of the literature showed that an alkali-soluble compound, 1-hydroxy-6-nitro-1 : 2 : 3 benzotriazole, is obtained on treating 2,4-dinitrophenylhydrazine with alkali. Accordingly, some of this compound was prepared by refluxing 2,4-dinitrophenylhydrazine with hydrazine hydrate[2], and its physical and chemical properties were compared with those of compound I isolated from *Mentha* leaves. The two substances were found to be identical with respect to infra-red spectra, melting characteristics and chromatographic co-ordinates.

This finding has an important bearing on the current use of 2,4-dinitrophenylhydrazine as a reagent for the detection of keto-acids. The artefact may interfere on one-directional paper chromatograms of keto-acid dinitrophenylhydrazones because its position overlaps that of pyruvic acid dinitrophenylhydrazone. The effect may, however, be minimized by avoiding an excess of reagent. In addition, the artefact may be partially separated from the slower-moving spot of pyruvic acid dinitrophenylhydrazone with certain solvents as shown in Table 1.

Table 1

Solvent	R_F values *A*	*B*	*C*
1-Hydroxy-6-nitro-1 : 2 : 3 benzotriazole	0·56	0·43	0·81
Pyruvic acid dinitrophenylhydrazone (slower-moving spot)	0·50	0·40	0·84

A, *t*-amyl alcohol/ethanol/water (ammonia vapour), 9/1/2.
B, *t*-amyl alcohol/*n*-propanol/ammonium hydroxide, 13/1/6.
C, 0·5 per cent sodium carbonate.

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Classification of the Antifungal Antibiotics from *Bacillus subtilis*

Several papers have recently appeared describing substances produced by *Bacillus subtilis* which exhibit antifungal activity with only incidental antibacterial action. Though the chemical and physical properties of these substances were not thoroughly investigated, it appears that some of them are similar and can be grouped together. Table 1 summarizes the known properties of nine of these antifungal antibiotics. It shows that whenever tested, these substances proved to be extracellular, acidic, non-dialysable and heat-stable polypeptides, not affected by pepsin and trypsin. They are soluble in polar, and insoluble in non-polar, organic solvents. Peptides I, II and III have an acid equivalent weight in the neighbourhood of 1,000, and an acid dissociation constant of about $pK = 5{\cdot}5$; as acidic polypeptides, they are soluble in alkali and insoluble in water and in dilute acids. Similar solubility properties were found for other substances of this group, as given in Table 1.

Two-dimensional paper chromatograms, made at Rehovot, of the acid hydrolysates of I, II and III, using phenol–water and butanol–acetic acid, showed that these three peptides are composed of the same amino-acids. In all three substances aspartic acid, glutamic acid, serine, threonine and tyrosine predominated, while alanine, leucine, phenylalanine and valine were found in relatively small quantities. An unidentified ninhydrin-positive spot was found in the neighbourhood of aspartic acid (Tint and Reiss[5] stated that their most purified samples of II contained the first five amino-acids only). A similar amino-acid composition was reported for IX[7]; aspartic acid, glutamic acid, tyrosine and leucine were found in VI[8]. No tryptophan, basic or sulphur-containing amino-acids were found in these antifungal antibiotics. The amino-acid composition of these substances is in agreement with their acid character and relatively low nitrogen and amino-nitrogen content.

Further evidence for the similarity of I, II and III may be found in their antibiotic spectra, as tested by us under identical conditions (Table 2). A survey of the literature showed that the other antifungal antibiotics listed in Table 1 have similar antimicrobial properties. No complete comparison of the antibiotic spectra could, however, be made, since different assay methods and various organisms have been used for the study of these substances.

Table 2. Comparative Antimicrobial Spectra of Bacillomycin *R* (I), Bacillomycin (II) and Fungocin (Bacillomycin *A*) (III). Methods of assay have been described elsewhere (ref. 1)

	Substances I	II	III
Bacteria:			
Escherichia coli	−	−	
Klebsiella pneumoniae	−	−	+ +
Staphylococcus aureus	−	−	
Pathogenic fungi			
Epidermophyton inguinale	+ +	+	+ +
Trichophyton mentagrophytes gypseum	±	−	
Trichophyton rubrum	+	−	+ +
Trichophyton violaceum	+	+	+ +
Candida albicans	±	−	+ +
Plant pathogens and saprophytes			
Aspergillus niger	+ +	+	+ +
Botrytis cinerea	+	±	±
Fusarium sp.	+	±	−
Penicillium notatum	+ +	+	+ +
P. roqueforti	+	+	+ +
Rhizopus nigricans	+	−	+

Key: + + Complete growth inhibition at 25–50 μgm./ml.
+ Complete growth inhibition at 50–100 μgm./ml.
± Complete growth inhibition at 100–200 μgm./ml.
− Growth not inhibited at 200 μgm./ml.

Although the three other antifungal polypeptides produced by *B. subtilis*, namely, fungistatin (antibiotic *XG*)[3], mycosubtilin[11] and "rhizoctonia factor"[6], are in many respects similar to the above nine substances, they differ in the following important properties: fungistatin is an amphoteric polypeptide, containing basic amino-acids and tryptophan; mycosubtilin is intracellular, does not dissolve in the lower aliphatic alcohols, does not contain glutamic acid and serine, and its acid equivalent weight is 1,980; "rhizoctonia factor" is dialysable, insoluble in butanol and ethanol and is inactive against *Aspergillus niger*. Thus these three cannot be included in the same group.

It is suggested that the nine substances listed in Table 1 be classified under one name. Although eumycin was the first substance of this group reported, it was not clearly enough characterized to warrant designating the whole group by this name. We

Table 1. Comparison of the Physical and Chemical Properties of Nine Antifungal Antibiotics produced by *B. subtilis*. Additional results for II and III obtained at Rehovot are marked •

Property	Substances I	II	III	IV	V	VI	VII	VIII	IX
Extracellular	+	+	+	+	+			+	+
Dialysable	−	−	−•		−	−	−		
Heat-stable	+	+	+	+	+	+	+	+	+
Absorbed on charcoal	+	+	+•			+		+	
Inactivated by pepsin and trypsin	−	−	−•		−	*a*			
Soluble in: Water	−	−	−				+[b]		−
Lower aliphatic alcohols	+	+	+	+	+	+	+	+	+
Ether	−	−	−	−	−	−	−	−	−
Chloroform	−	−•	−		−			−	
dil. NaOH	+	+	+	+	+	+			+
dil. HCl	−	−	−	−	−	−			−
Conc. acids	+	+	+		+				
Ninhydrin reaction	−	+•	+•		+	−			+
Type of polypeptide	acid	acid	acid		acid	acid			acid
Acid equiv. weight	1,000	940	1.100•						
pK	5·5	5·6	5·4•						5·8
Per cent NH_2/N	0·15	0·75•	0·30•			0·27			
Per cent total N	13	12·4•	11·7•			10–11			
Hæmolytic at 1 : 10,000	+	+•	+•	*c*					*c*

(*a*) Not inactivated by bacterial proteinase (non-papain type).
(*b*) The reported water-solubility of VII may be due to its method of preparation, in which a soluble salt was formed.
(*c*) Strongly hæmolytic, concentration not reported.

Key: I Bacillomycin *R* (ref. 1).
II Bacillomycin (ref. 5).
III Fungocin (ref. 2) (bacillomycin *A*).
IV Eumycin (ref. 4).
V Toximycin (ref. 10).
VI Bacillomycin *B* (ref. 9).
VII 'Aspergillus factor' (ref. 6).
VIII (ref. 8) and IX (ref. 7), unnamed.

suggest, therefore, the name 'bacillomycin' be used, particularly since it indicates both the synthesizing genus and the organisms most susceptible to this group of antifungal antibiotics. Until they are completely characterized the various members of this family may be designated by letters following the name. In accordance with this suggestion, one of us (A. P. C.) agrees to change the name of 'fungocin' to 'bacillomycin A'.

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Separation of Proteolytic Enzymes of *Clostridium histolyticum*

Previous attempts to separate the proteolytic enzymes found in culture filtrates of *Cl. histolyticum* have been largely unsuccessful. Methods for preparing proteinase free of collagenolytic activity have been described[1]; but collagenase free of other proteolytic activity has never been obtained.

Complete separation with more than 80 per cent recovery of all enzymatic activity has now been achieved by a simple method of fractional precipitation with saturated ammonium sulphate solutions neutralized with ammonium hydroxide to a *p*H of 7·5.

The starting material was a 2 per cent solution of crude enzyme prepared by precipitating the culture filtrate with 400 gm./l. of solid ammonium sulphate[1,2]. To this solution the saturated ammonium sulphate was added slowly and stepwise at room temperature. After each stepwise addition the precipitate was centrifuged off, dialysed and freeze-dried, and a further amount of saturated ammonium sulphate added to the clear supernatant.

In this way four peaks of different enzymatic activities could be distinguished: a proteinase peak (*A*), a collagenase peak (*B*), an amidase-esterase peak (*C*) and a peptidase peak (*D*) (see Fig. 1).

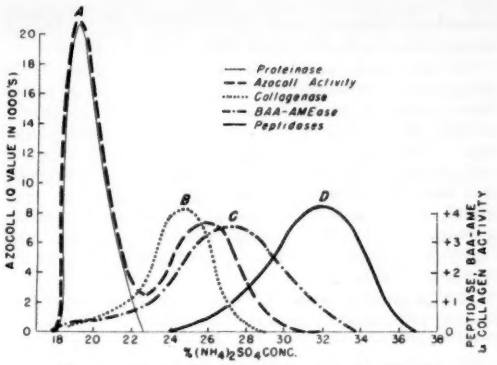

Fig. 1. Fractional precipitation of crude enzyme

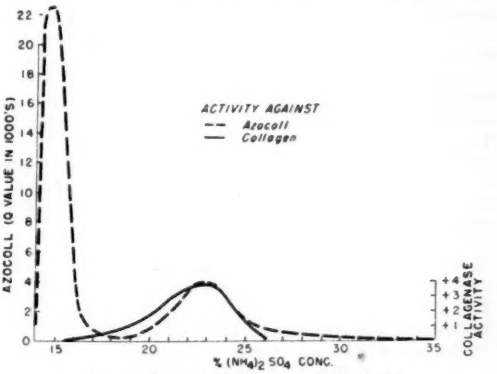

Fig. 2. Reprecipitation of proteinase peak

The proteinase of peak *A* is identical with that previously described by us[1] and referred to as δ-enzyme. However, this fraction is free of blood-group *A* substance and has a potency fifty times greater than that of our previous preparations. By refractionation (see Fig. 2) it has been completely freed of collagenase and peptidase activity and most of the amidase-esterase. It is active against the following substrates: azocoll[3,1], gelatine, hide-powder, casein, hæmoglobin, coagulated egg albumin, coagulated bovine plasma albumin and fresh fibrin clots (Table 1).

At 24–27 per cent saturation (peak *B*) collagenase is reprecipitated, free of proteinase and low in peptidase activity; amidase-esterase is still present.

Table 1. Specificity of *Cl. histolyticum* Enzymes

	Protein-ase	Collag-enase	Amidase-esterase	Peptid-ases
Azocoll	+	+	?	0
Collagen	0	+	–	0
Gelatine	+	+	?	?
Casein	+	0	0	0
Hæmoglobin	+	0	0	0
Egg albumin	+	0	0	0
Bovine plasma albumin	+	0	0	0
Fresh fibrin clots	+	0	0	0
Benzoyl arginine amide (cysteine-activated)	0	0	+	0
Arginine methyl ester (cysteine-activated)	0	0	+	0
Leucylglycine (cobalt-activated)	0	0	0	+
Leucylglycylglycine	0	0	0	+
Valyl deca peptide	0	0	0	+

The collagenase is active against native collagen, azocoll and gelatine, but has no effect against casein, hæmoglobin, albumin and fibrin (see Table 1).

The amidase-esterase is the third enzyme to be precipitated from solution, reaching a point of maximum precipitation at about 28 per cent (peak *C*). At this point most of the collagenase has been salted out. Because of the large difference in ratio of collagenase to amidase at peaks *B* and *C* respectively and for other reasons which will be published elsewhere, we consider the amidase-esterase a separate enzyme. It attacks benzoyl arginine amide and arginine methyl ester and is strongly activated by cysteine (Table 1).

The peptidase peak (*D*) appears to correspond to several peptidases not separated from each other as yet. The later fractions (32–35 per cent) are free of collagenase, other proteinases and amidase-esterase. One constituent is a cobalt-activated dipeptidase attacking leucylglycine, leucylalanine, etc., and the other is an aminopolypeptidase needing no activation. It is active against leucylglycylglycine and the decapeptide synthesized by Erlanger *et al.*[4] which contains valine at the terminal amino-position. Activity against other peptides is being studied (Table 1).

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Production of Unsaturated Uronides by Bacterial Hyaluronidases

Pneumococcal hyaluronidase has been shown to hydrolyse only the glucosaminidic bonds of hyaluronate[1]. The pneumococcal enzyme and other bacterial hyaluronidases have further been shown to differ from hyaluronidases of animal origin in their thermal lability, and in their capacity to hydrolyse hyaluronate faster and more completely. The main product of exhaustive hydrolysis of hyaluronate by testicular hyaluronidase is a tetrasaccharide[2], whereas the end-product of the action of pneumococcal hyaluronidase is a fraction having the reducing values of a disaccharide[1].

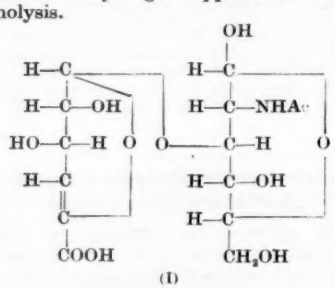
The pneumococcal product differs markedly, however, from N-acetylhyalobiuronic acid, the repeating unit of hyaluronate[3] and of the oligosaccharide fractions obtained on digestion with testicular hyaluronidase[2] as demonstrated in Table 1. The values indicate that the bacterial product is a disaccharide. It is also produced with hyaluronidases of varying degree of purity prepared from cultures of streptococci, staphylococci and *Clostridium welchii*.

Table 1

Analysis	'Bacterial' disaccharide	N-acetylhyalobiuronic acid
Reducing sugar* (hypoiodite)	1·05 mgm./mgm.	0·70 mgm./mgm.
Reducing sugar* (ferricyanide)	0·58 mgm./mgm.	0·68 mgm./mgm.
Hexosamine	42·3 per cent	44·4 per cent
Uronic acid (CO_2)	44·8 „ „	48·2 „ „
Uronic acid (carbazole)	40·3 „ „	48·6 „ „
Acetylglucosamine end-group colour (ref. 4)	0·99 mgm./mgm.	1·15 mgm./mgm.
$[\alpha]_D^{25}$	−20·0	−32·0
R_F	0·38	0·24

* As glucose.

On acid hydrolysis of the bacterial disaccharide, D-glucosamine has been obtained as the hydrochloride in a yield of 74 per cent and characterized as the carbobenzoxy compound. The bacterial disaccharide shows the following behaviour, which further distinguishes it from N-acetylhyalobiuronic acid. It consumes one mole of bromine, and has an absorption maximum at 230 mμ typical of α-β-unsaturated carbonyls, and yields on ozonolysis oxalic acid. On hydrogenation with palladium on charcoal, the disaccharide takes up two moles of hydrogen. This product, homogeneous by paper chromatography, no longer absorbs at 230 mμ, fails to give the carbazole reaction of uronic acids and is not decarboxylated on heating with acid. Its aldehydic function, however, is still intact as evidenced from the hypoiodite titration and the colour value in the modified Elson–Morgan reaction[4]. The results indicate a 4–5 unsaturated uronide of the following tentative structure (I). The consumption of the second mole of hydrogen appears to be due to hydrogenolysis.



(I)
'Bacterial' disaccharide

The exhaustive hydrolysis of hyaluronate by bacterial enzymes yields the unsaturated disaccharide in almost quantitative yield, whereas from tetrasaccharide, obtained with testicular hyaluronidase, the bacterial enzymes yield equal quantities of N-acetylhyalobiuronic acid and the unsaturated disaccharide (the acid itself was recovered unchanged after incubation with bacterial hyaluronidase). When the hydrolysis of hyaluronate by bacterial enzymes is not allowed to go to completion, oligosaccharides are isolated which differ chromatographically from those obtained from testicular digests. Resistance of these fractions to β-glucuronidase[5] indicates that the non-reducing glucuronidic end-group is modified. These results strongly suggest that the double bond is formed during hydrolysis of the glucosaminidic bonds by dehydration of the glucuronidic groups.

One enzyme appears to catalyse both the hydrolysis and the dehydration. The mechanism of the reaction may be explained by the assumption that the water of hydrolysis of the hexosaminidic bonds is furnished

by the adjacent uronidic group instead of by the medium. The glucosaminidic linkages of hyaluronic acid are claimed to be in the 3-position on the basis of a negative periodate consumption (see ref. 3). Therefore the double bond either migrates into the conjugated 4–5 position or the original bond actually is not in the 3- but in the 4-position. The latter is more probable.

The dehydrative hydrolysis is not limited to hyaluronate and to oligosaccharide fractions prepared from it. The naturally occurring polysaccharide chondroitin and partly desulphated oligosaccharide fractions obtained by acid hydrolysis from chondroitin sulphate *A* [6] are hydrolysed by bacterial hyaluronidases with concomitant dehydration.

It is to be expected that other glycosidic bonds will be hydrolysed dehydratively and that unsaturated sugars and products derived from them similar to those described here may occur in Nature.

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Lungworms (*Metastrongylus* spp.) in Pigs, and their Development in the Guinea Pig

THE three species of the genus *Metastrongylus*, *M. apri* Gmelin, *M. pudendotectus* Vostokov and *M. salmi* Gedoelst, occur in the pig; but the last has only been found in the Belgian Congo, the United States and the U.S.S.R. The two former species occur in Great Britain[1]; but opinion differs as to their incidence, probably because of a failure to recognize the rather inconspicuous lesions they produce in adult pigs (personal replies to a questionnaire).

During the past two years we have studied the incidence of the worms in pigs at a bacon factory in Cheshire, the occurrence of lungworm eggs in the fæces of pigs, the development of lungworms in earthworms (intermediate host), and the experimental infection of laboratory animals. A short note on the first year's findings has already appeared[2], and the present communication records briefly the most important results of the work of two years. Detailed accounts will be published elsewhere.

The discovery of virus pneumonia in pigs and the suggestion that it is very widespread and causes considerable economic loss[3] make it desirable to distinguish it from other conditions that cause pigs to cough.

Of 1,308 bacon pigs examined between February 1954 and March 1954, the lungs of 18·2 per cent were infected. These pigs came from 224 individual consignments, 44·2 per cent of which contained one or more infected pigs; this means that lungworms existed in almost half the batches of bacon pigs coming to the factory from north-west Britain. We have found lungworms as frequently in other areas, too. Many naturally infected pigs harbour only very light worm burdens, and the lesions in such pigs may be confined to the extreme tip of the diaphragmatic lobe. Often the parasites can be found only if the finest bronchi are opened. The usual lung lesions in bacon pigs are pale wedge-shaped areas of emphysema, situated mainly along the postero-lateral border of the diaphragmatic lobe. Pneumonic changes are seldom associated with these lesions, and are much more common in the apical and cardiac lobes.

Examination of a large number of samples of fæces from naturally infected pigs failed at first to yield lungworm eggs. The explanation was later found to lie in the failure of saturated sodium chloride solution (spec. grav. 1·200) to bring the eggs to the surface when 2-gm. samples of fæces were examined by centrifuging at 1,500 r.p.m. for three min. Experiments showed that saturated sodium chloride yielded only 1/200 to 1/20 of the eggs given by saturated magnesium sulphate ($MgSO_4,7H_2O$, spec. grav. 1·285) used in the same way. Table 1 shows the counts of lungworm eggs with the two flotation solutions for six samples of fæces chosen from a total of twenty-three samples examined. Magnesium sulphate will reveal with great accuracy very small numbers of lungworm eggs, and counts of 2–5 eggs per gm. have been obtained regularly over a series of weeks from infected pigs. Low egg-counts are common in naturally infected pigs and would be missed if the usual routine fæces examination with sodium chloride were used. The mean of the counts for the twenty-three samples was 4·4 eggs per gm. for sodium chloride and 294 eggs per gm. for magnesium sulphate. That the superiority of magnesium sulphate is not due solely to its specific gravity is shown by the fact that a saturated solution diluted to specific gravity 1·200 was almost as effective as the fully saturated solution. The failure of sodium chloride to float the eggs of the pig lungworms was pointed out nearly twenty years ago by Russian workers[4], who also showed the value of magnesium sulphate; but their findings do not seem to have been widely recognized.

Cultures of various species of earthworms have been successfully established[2] and a number of species have been infected with lungworms. *Eisenia foetida* was the species most easily cultured and infected, but is rare on pig pastures. *Allobophora nocturna*, *A. caliginosa*, *A. chlorotica* and *Lumbricus rubellus* have also been infected, and all these species occur in pasture land.

Table 1. COMPARISON OF SATURATED SODIUM CHLORIDE AND SATURATED MAGNESIUM SULPHATE FOR FLOTATION OF EGGS OF LUNGWORMS (*Metastrongylus* SPP.) IN THE FÆCES OF NATURALLY AND EXPERIMENTALLY INFECTED PIGS

Sample No.	Eggs per gm. of fæces	
	Sodium chloride	Magnesium sulphate
1 (*E*)	10·5	2,226
2 (*E*)	5	544
3 (*E*)	3	130
4 (*N*)	1	56
5 (*N*)	0	44
6 (*N*)	0	6

(*E*), Experimentally infected; (*N*), naturally infected.

Fig. 1. Section through bronchus of guinea pig infected with *M. apri* showing ten adult worms in the lumen. Eight of the nine females show embryonated eggs containing larvæ. Hæmatoxylin and eosin. × 145

Guinea pigs have proved to be the most satisfactory laboratory animal for infection with the pig lungworm, and a total of 116 young guinea pigs (150–350 gm. body-weight) have been given third-stage infective larvæ by mouth. More than 50 per cent have become infected with lungworms, and in the most recent experiments the infection-rate has been 80–100 per cent. In one experiment with eight animals, all became infected and six of them showed at autopsy four to seven weeks later a large number of mature adult female worms containing viable embryonated eggs (Fig. 1).

Lungworm eggs, identical in appearance with those found in pigs, were found in the fæces of three of the guinea pigs by magnesium sulphate flotation. Eggs recovered from the female worms in the guinea pig lung produced infective larvæ in *Eisenia foetida*, and a guinea pig was successfully infected with these larvæ. Previous workers have reported that experimental infections in guinea pigs have failed to yield fertile eggs[5], and we believe this to be the first such record. We are now trying to adapt the lungworm to the guinea pig in the hope of obtaining 100 per cent infection with regularity. This would provide a useful experimental tool for the study of lungworms in domestic stock, because there would then be both an intermediate host (earthworm) that could be maintained and infected with ease and also an experimental animal as definitive host (guinea pig) which would be available in large numbers for chemotherapeutic tests and biological studies.

In our experimental work on guinea pigs, we have confirmed the finding of Porter[6] that basophilia is a feature of infection in the guinea pig and have found it to be preceded by an eosinophilia which soon subsides. Re-infection when the basophilia and eosinophilia had lapsed produced a recurrence of the same blood picture.

All our experimental work on pigs and laboratory animals has been carried out with *M. apri*, which is the more common of the two species in the pig in Great Britain. *M. pudendotectus* is usually present along with *M. apri*, but in much smaller numbers. We have not found *M. salmi*.

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Effect of Acetate on the Fasting Blood-Sugar Level of the Rat

Chari and Wertheimer[1] state that intraperitoneal injection of acetate (100 mgm./100 gm. body weight ?) into rats "caused hypoglycæmia and increased alkalosis" but give no details of their experiments. In view of the known interrelationship between glucose and acetate in the ruminant[2], it was considered of interest to investigate this point further.

Blood samples were taken by heart puncture under 'Nembutal' anæsthesia from adult rats previously fasted for 17 hr. before and 30, 60, 120 and 180 min. after intraperitoneal injection of sodium acetate or an equivalent amount (in terms of sodium) of saline. The solutions injected were isotonic at a dose-rate of 100 mgm./100 gm. body-weight and of twice this concentration at a 200 mgm./100 gm. level. Acetate appears to produce a slight hyperglycæmia of short duration, the effect being most marked when 100 mgm./100 gm. was given ; in no case was there any subsequent marked hypoglycæmia compared with the results in animals given saline at the corresponding level. The type of diet apparently had little, if any, effect on the response to acetate. A transient hyperglycæmia may be expected in view of the known effect of acetate on depressing glucose uptake by various rat tissues[3,4] and agrees with the findings of Reid in the sheep[3].

The effect of incorporation of acetate in the diet of weanling rats was also investigated. One group of seven animals was given 8 gm. of powdered rat cubes per rat daily, mixed with milk, and a second group of six animals was maintained on the same diet mixed with increasing amounts of acetate in the form of a solution of sodium acetate. It was evident from the growth curves that only a limited amount of acetate could be incorporated in the diet if growth was to continue normally. The maximum level tolerated appears to be of the order of 13 per cent of the diet. Acetate fed at this level had no effect on 17-hr. fasting blood-sugar levels. A transient hypoglycæmia induced in rats on a diet containing

16·5 per cent sodium acetate was presumably largely due to starvation.

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A Method of collecting Fluid leaving the Omasum of Sheep

In ruminants a large proportion of the ingested food is digested in the fore-stomachs. In order to know the final result of this digestion, it is necessary to know the composition of the material leaving the fore-stomachs and the rate of flow at the omaso-abomasal orifice. To study this problem a special cannula has been devised (Fig. 1). It consists of a main tube, *B*, of ebonite (2 cm. internal diameter), into which runs a smaller one, *C* (1 cm. internal diameter). The main tube is 10 cm. long and is connected at one end with a funnel, *A*, of which the diameter of the top is 6 cm. and its height 4 cm. The side tube, *C*, is screwed perpendicularly on to the middle of the main tube. It is threaded on the outside over its whole length, so that an ebonite ring (*D*) of 3 cm. diameter can be screwed on to it, making it mobile over the whole length of the tube.

For the operation, the anæsthetized sheep is put on its left side. The abdominal wall is incised just behind the ribs from the median line about 20 cm. upwards. After opening the abdomen, the abomasum is exposed and a small incision is made in it through which the large tube is slid so that the opening of the funnel fits against the omaso-abomasal orifice, and the main tube lies completely in the abomasal lumen. After screwing the side tube on to the main one, the abomasal wall is sutured. A ligature is put around the abomasum just under the funnel in order to keep the tube in place; when inserting this ligature, care is taken not to damage the main nerves and blood vessels. It is tightened just sufficiently to prevent the funnel from passing through. Just behind the ribs and next to the main incision a stab wound is made in the abdominal wall through which passes the side tube. The various layers of the abdominal wall are then sutured. The ring is screwed on the side tube just up to the skin and the tube is corked.

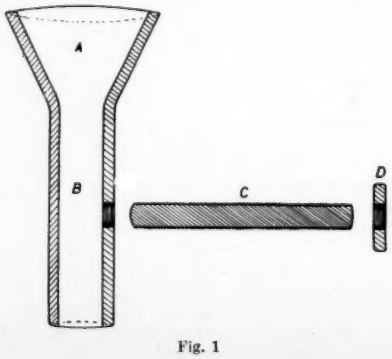

Fig. 1

For the collection of fluid leaving the omasum, a balloon is passed through the side tube into the distal part of the main tube, which is blocked by insufflation of air into the balloon. The fluid leaves the side tube at fairly regular intervals; its dry-matter content varies between 5 and 10 per cent. The *p*H is usually slightly higher than the *p*H of the ruminal fluid.

Living protozoa are found in the fluid. A very great variation has been found in its chlorine content, although this is always much higher than that of the ruminal fluid. The amount of pepsin, usually present in traces, depends upon the position of the front part of the funnel. It has been shown that the cannula does not interfere with the normal movements of the rumen and reticulum.

More detailed results obtained with this procedure will be published elsewhere.

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Serous Cells in Brunner's Glands of the Rabbit

In Brunner's glands of the rabbit's duodenum there are numerous groups of serous-type cells lying among the mucous acini. It has long been believed that these cells are of a nature similar to those of the pancreatic acini. According to Patzelt[1], Schwalbe (1872) was the first to make the suggestion, and he quotes the work of later authors who have added confirmatory evidence: the cells have similar staining reactions to those of the pancreatic acini, and they undergo compensatory hypertrophy after the pancreatic duct is ligated; rabbits so treated remain in good health.

In a previous communication[2], it was pointed out that in sections of rabbit duodenum treated histochemically by Gomori's 'Tween' technique for 'lipase', these serous cells are strongly 'lipase'-positive and stand out sharply among the 'lipase'-negative mucous acinar cells. The suggestion was made that the 'lipase'-positivity might be a point in favour of the above view. This has now been explored further.

It was felt that if it could be shown that the 'lipase' reaction given by these cells is due to true lipase, then the above view would be substantiated very considerably, since true lipase is almost confined to the pancreatic acinar cells. True lipase can be readily distinguished from non-specific esterase by the influence of bile salts upon the activity of the enzyme. It has been demonstrated chemically[3] and histochemically[4] that bile salts activate true lipase and inhibit non-specific esterase. This fact formed the basis of the present work.

Specimens of duodenum from each of six rabbits were fixed in absolute acetone, cleared in benzene, embedded in paraffin and serially sectioned at 7 μ. A histochemical study was made of the 'lipase' activity of the sections, employing a modification of Gomori's 'Tween' technique[5], namely, a method in which the sections are introduced directly into the substrate without prior dewaxing[6]. Adjacent sections of each specimen were taken; one was incubated in the usual 'Tween' substrate bath ('Tween 40' was employed throughout) and the other in a 'Tween' substrate bath containing 0·2 per cent sodium

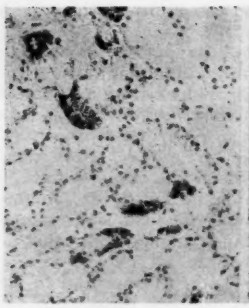

Fig. 1

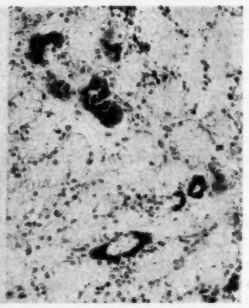

Fig. 2

Fig. 1. Brunner's glands of rabbit duodenum. × 110. 2 hr. incubation in a normal 'Tween' substrate bath. There is a reaction in groups of serous cells lying among the lipase-negative mucous acinar cells

Fig. 2. Adjacent section to that of Fig. 1. × 110. 2 hr. incubation in a 'Tween' substrate bath containing 0·2 per cent sodium glycocholate. Note marked intensification of the reaction in the serous cells

Nuclei were lightly counter-stained with hæmatoxylin

glycocholate. The incubation periods were the same for each of the two sections.

The results were quite definite and striking. After incubation over-night, all the sections incubated in the normal 'Tween' substrate bath showed the usual reaction in the serous cells among Brunner's glands and in the surface epithelial cells of the villi and upper parts of the crypts. In all sections that had been incubated in the presence of bile salt, the reaction in the villi and crypts either had not appeared at all or was very faint (indicating that the enzyme activity there is due to non-specific esterase); but the reaction in the serous cells among Brunner's glands was particularly intense.

In order to demonstrate more clearly that activation of the reaction in the serous cells takes place, adjacent sections were incubated in the two substrates for such short periods as 1, 2 and 3 hr. After 1 hr. there was already a reaction in the sections incubated in the presence of bile salt, but none in those incubated in the normal substrate bath. After 2 or 3 hr., a reaction was present in both sections, but was much more intense in that incubated in the presence of bile salt. A typical result obtained after 2 hr. incubation is illustrated in Figs. 1 and 2.

This experiment shows that these serous cells, like the cells of the pancreatic acini, contain true lipase. Moreover, the reaction is localized mostly in the apical parts of the cells, as it is in the acinar cells of the pancreas. This finding adds strong support to the view that these serous cells in Brunner's glands of the rabbit are of the same nature as the acinar cells of the pancreas.

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Biochemical Changes in Cultured Cells

The *in vitro* culture of blood or bone marrow cells is frequently employed in hæmatological studies. Since it is uncertain how far *in vitro* conditions approximate to *in vivo* ones, it is important to collect as much evidence as possible bearing on the life of cultured cells. It is not enough that they should merely exist in a state of torpor; but there should be some indication of the occurrence of proliferative activity or of cell maturation and differentiation. Although ample morphological evidence of both these processes in bone marrow cells in fluid media has been put forward[1,2], it is desirable to demonstrate that such cultures are also 'biochemically alive'. Measurements of cellular nucleic acids may reveal maturation and differentiation of cells of the hæmopoietic system, for it has already been shown that the ribonucleic acid content of the cytoplasm of primitive marrow cells is much greater than that of the mature differentiated forms[3,4]. We have studied the quantitative changes taking place in nucleic acids during the culture of bone marrow cells.

Some results of a number of experiments on the culture of bone marrow cells from patients suffering from pernicious anæmia, using a standard technique[5], are summarized in Table 1. The nucleic acid content of the culture was estimated by a microchemical method[6] and correlated with the number of cells per cu.mm. The mean amounts of deoxyribonucleic acid phosphorus per cell at 0 hr. and 48 hr. were found, in any one experiment, to be very similar, indicating that the cellular contents of deoxyribonucleic acid phosphorus did not vary during culture.

Grand mean of the 19 cultures at 0 hr. = 8·06 × 10^{-9} µgm. per cell.
" " " " 19 " " 48 " = 8·38 " " " "

The mean content of ribonucleic acid phosphorus per cell, on the other hand, was in most experiments lower at 48 hr. than at 0 hr., indicating cell maturation and differentiation. The most useful information, however, was obtained from consideration of changes in the ratio of ribo- to deoxyribo-nucleic acid phosphorus, for this avoids the errors in cell enumeration. Examination of the figures suggests strongly that a fall in this ratio is the rule, but that the rate of fall varies from experiment to experiment. However,

Table 1. Ratio of Ribo- to Deoxyribo-nucleic Acid Phosphorus in Culture Media at 0 and 48 hr.

Exp. No.		50% pernicious anæmia serum	50% pernicious anæmia serum + vitamin B_{12} (0·05 µgm./ml.)	50% pernicious anæmia serum + folinic acid (7·5 µgm./ml.)	50% normal serum
2	0 hr.	4·8	6·2	3·0	—
	48 "	1·1	1·1	1·4	—
3	0 "	3·0	—	—	—
	48 "	1·7	—	—	—
4	0 "	2·2	2·0	2·3	
	48 "	1·9	1·9	2·2	—
5	0 "	1·4	—	—	2·1
	48 "	0·9	—	—	1·3
6	0 "	1·3	1·0	—	0·9
	48 "	1·6	2·4	—	3·6
8	0 "	2·4	4·2	—	—
	48 "	2·2	1·9	—	—
9	0 "	3·1	3·1	—	—
	48 "	3·1	2·7	—	—
10	0 "	3·1	2·7	3·2	—
	48 "	2·3	2·2	1·9	

Table 2

Exp. No.	Mean ratio ribo- to deoxyribo-nucleic acid phosphorus 0–48 hr.	t*	Deg. of freedom	P'	$-\log_e P'$
2	3·46	3·721	4	0·0102	4·5854
4	0·16	1·250	4	0·140	1·9661
5	0·65	1·612	2	0·124	2·0875
6	−1·3	2·169	4	0·952	0·0492
8	1·30	1·422	2	0·146	1·9242
9	0·195	0·812	2	0·251	1·3823
10	0·90	4·658	4	0·0048	5·3391
					17·3338

P', iducial probability that the true mean difference is not positive· that is, $P' = \frac{1}{2}(P$ of Fisher) except in Exp. 6, where $P' = 1 - \frac{1}{2}$ (Fisher's P).

* The 0- and 48-hr. series were treated separately in calculating t. Use of the series of differences leads to $\chi^2 = 29{\cdot}88$, $P < 0{\cdot}01$.

we are not concerned here with varying rate of change, or with effects of added substances which, apparently, are unimportant. When each experiment is used for providing independent evidence of a fall in the ratio and the results are pooled by the method advocated by Fisher[7], results are obtained as shown in Table 2. It is evident that, although the fall in the ratio is significant only in experiments 2 and 10, the aggregate evidence for a fall is very significant; $\chi^2 = 34{\cdot}6676$ with 14 degrees of freedom, $P < 0{\cdot}01$.

We consider that the results indicate that in these bone marrow cultures maturation and differentiation of cells is proceeding, a process that involves loss of ribonucleic acid phosphorus from the cell, which maintains a relatively constant content of deoxyribonucleic acid phosphorus.

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Aug. 18.

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[2] Lajtha, L. G., *J. Clin. Path.*, **5**, 67 (1952).
[3] Thorel, B., *Acta Med. Scand.*, Supp. 200 (1947).
[4] White, J. C., *J. Path. and Bact.*, **59**, 223 (1947).
[5] Feinmann, E. L., Sharp, J., and Wilkinson, J. F., *Brit. Med. J.*, ii, 14 (1952).
[6] Davidson, J. N., Leslie, I., and Waymouth, C., *Biochem. J.*, **44**, 5 (1949).
[7] Fisher, R. A., "Statistical Methods for Research Workers", § 21.1 (11th edit., 1950).

Nuchal Crests in Australopithecines

In his reply to my recent communication in *Nature*[1], Prof. S. Zuckerman questions my statement that direct evidence is available that the Swartkrans prehominid did not have a "powerful and shelf-like"[2] nuchal crest even when a sagittal crest was present.

This evidence is most clearly seen in the Swartkrans skull *SK*.49, the occipital region of which has now been prepared in acetic acid. The skull has been sheared considerably, but the region from slightly posterior to the glabella to approximately the position of the bregma, as well as a good deal of the occipital region, are little disturbed and the bone surface in these regions is so well preserved as to show the minutest details of structure. Approximately five and a half centimetres of the frontal region is preserved in the mid-line, and this bears a low sagittal crest, 2·6 cm. of which is preserved. This crest is lower than those of skulls *SK*.46 and *SK*.48. The well-preserved occipital portion extends from the left mastoid to approximately 1 cm. to the right of the mid-line—here indicated by the posterior end of the sagittal suture and by the inion. In the mid-line the bone surface is undamaged from half a centimetre below the inion to nearly 3 cm. above it. To the left of the mid-line the preserved area is greater. The whole of the superior nuchal line is well preserved on the left side between the mastoid and the inion. A clearly defined but small external occipital protuberance is situated 2·8 cm. below the lambda. The sagittal and lambdoid sutures are here quite apparent. Disturbance of the bone just above the lambda has resulted in both sutures being pulled slightly apart in this region and it is manifest that no fusion had yet occurred. There is no trace of a sagittal crest in the mid-line, along either the 2·8 cm. of perfectly preserved bone from inion to lambda, or on the centimetre of disturbed bone above lambda, where the bone is well enough preserved to have shown it had there been a crest. A small sagittal crest is therefore actually present near the bregma but none in the occipital region, nor does the left temporal line reach anywhere near the mid-line in this region.

The superior nuchal line is very weakly developed for 1·9 cm. to the left of the inion, is then drawn out into a low ridge for a distance of 2·7 cm., after which it is again a barely perceptible line for the remaining 2·4 cm. of the specimen. At its maximum development this ridge is 3 mm. high, measured on the upper side. Even at this point of maximum development the planum nuchale passes downward and forward directly from the ridge crest, that is, the ridge results largely from the planum occipitale being a little depressed just above it. There is, therefore, not even a continuous ridge across this region, let alone a "powerful and shelf-like" nuchal crest.

Zuckerman[1] suggests that the Makapan occiput belonged to an immature individual because the sagittal and lambdoid sutures had not yet completely fused—although he gives no reasons for supposing that this criterion is applicable to the australopithecines. In *SK*.49 the upper post-canine dentition is *in situ* and well preserved. M^1 is so much worn that the enamel is worn through over the protocone and is about to go through over the hypocone, M^2 is worn on all four cusps and M^3 already shows some wear. By any reasonable standards this specimen must be considered fully mature, yet its sagittal and lambdoid sutures are not fused. The corresponding sutures of the Makapan specimen had already started fusing[3], hence there is no reason for supposing that it is not fully mature also. A second calvarial fragment from Makapan has the temporal lines approaching the mid-line fairly closely but not reaching it, and this shows that the point of nearest approach to the mid-line is distinctly anterior to that at which the former specimen is broken. If the temporal lines of the former specimen conform to the same pattern, as they appear to do, then they must have met farther forward and formed a small crest.

SK.48, from Swartkrans, is also a mature adult skull—the molars are in much the same stage of wear as are those of *SK*.49. Although the occiput is distorted and displaced, almost the whole of the right superior nuchal line from near the mid-line to the mastoid is present. This shows a condition similar to that of *SK*.49, except that the central part is drawn out into a ridge which reaches a maximum

height of 6 mm. The length of the ridge is about two and a half centimetres. In the bregma region the anterior 2 cm. of a sagittal crest is well preserved. Although the preserved anterior part of this crest is shorter than that in *SK*.49, it is already higher at the point at which the break occurs and was therefore almost certainly an appreciably larger crest. Nevertheless, this specimen, like *SK*.49, did not have a continuous or shelf-like nuchal crest.

Zuckerman says that my description of *SK*.48 differs from the 'official' one. Broom[4] said that "all the lower part of the occiput is preserved, but much crushed forward and upward into the brain region"—which says nothing about the state of preservation of the occiput, merely that in the crushing of the skull it has been displaced forward and upward. I stated[1] that "the greater part of the occiput is present but is a bit distorted and displaced", that is, it is not only displaced but also distorted. Except that Broom said nothing about the distortion, our statements differ only in regard to the exact degree of displacement—which tells nothing about the amount of detail to be observed on the occiput. Zuckerman[2], on the other hand, referring to *SK*.48 and *SK*.46—which were at that time the only skulls mentioned in the literature as having sagittal crests—says, "Unfortunately the occipital region of both skulls is lacking". It might be added that in the introduction to the volume which Zuckerman regards as official we state that it is "only a preliminary account".

Zuckerman doubts the correctness of referring the pelvis and spinal column from Sterkfontein to the Sterkfontein australopithecine on the grounds that "a manifestly human mandible has been found in the same deposits as have yielded the australopithecine apes". The 'human' mandible is presumably that of *Telanthropus*. The pelvis and spinal column were recovered from Sterkfontein, from the same single mass of consolidated breccia as were the several score of australopithecine remains. No other hominoid remains have been found at this site. The *Telanthropus* remains occurred *in situ* at Swartkrans, nearly a mile away, in company with the remains of an australopithecine quite different[5] from that at Sterkfontein. Swartkrans is geologically more recent than Sterkfontein—as is clearly shown by the fact, among others, that *Equus* and *Papio* occur at the former site but not at the latter. To doubt the relationship of the pelvis to the cranial remains at Sterkfontein because *Telanthropus* occurs in a quite different and geologically younger site is clearly inadmissible.

Zuckerman has given much information about the occurrence of nuchal crests associated with sagittal crests in many different primates. The question whether these two were also associated in the australopithecines will not be solved by studying bigger and better collections of modern pongids, monkeys, etc., but by studying australopithecines. So far they have yielded no evidence in support of this thesis, but some direct evidence against it.

J. T. Robinson

Transvaal Museum,
Pretoria.
Sept. 9.

[1] Robinson, J. T., *Nature*, **174**, 262 (1954).
[2] Zuckerman, S., in "Evolution as a Process" (Allen and Unwin, London, 1954).
[3] Dart, R. A., *Amer. J. Phys. Anthrop.*, n.s., **6**, 259 (1948).
[4] Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, No. 6 (Pretoria, 1952).
[5] Robinson, J. T., *Amer. J. Phys. Anthrop.*, n.s., **12**, 181 (1954).

The essential point at issue, which Dr. Robinson contested in his first communication[1], is the general proposition[2] that the presence of a sagittal crest in the skull of an Old World primate implies the presence of a nuchal (= occipital) crest; and further, that if one of the two is absent, it is usually the sagittal crest. "Unless *Paranthropus crassidens* is the one exception to a morphogenetic process common to all known Primates", I therefore suggested that the fact that two presumed female *Paranthropus* skulls were furnished with high sagittal crests implied that they had also possessed powerful occipital crests and an ape-like planum nuchale. In turn this implied a nuchal musculature and a carriage of the head on the vertebral column of the kind that is seen in the ape. I also suggested that this conclusion was consistent with certain other features of the Australopithecine skull.

Dr. Robinson now admits that *SK*.49, a specimen to which he referred before[1] in a few lines, and which he now describes for the first time—and all students of the subject will be grateful to him for this description—has a nuchal crest which is drawn out into a ridge that projected 3 mm. He also now states that the corresponding figure in *SK*.48, which he previously described as having a "well-marked occipital crest"[3], is 6 mm. Nuchal crests which are no more prominent—and indeed some less prominent—will be found in many adult apes. He and I have, therefore, no argument, regardless of the concluding sentence of his communication. Both his specimens possess nuchal or occipital crests, and both conform to the generalization to which he had previously taken exception. His observation that the crests were deficient in the mid-line also fits in with what I was at pains to point out in my previous communication[4]—namely, that in the ape the least prominent part of the nuchal crest is not infrequently in the mid-line, where, indeed, it is sometimes deficient.

For the rest, I fear that I still find it difficult to equate Broom and Robinson's[3] description of the occipital region of *SK*.48 as "very considerably crushed upwards and forwards" with Robinson's present statement[1] that it is merely "a bit distorted and displaced". Nor do I share his assurance (*a*) that it is possible to assess the maturity or otherwise of a fragment of one skull by appealing, via an apparent correspondence of sutural closure, to the dental wear of another specimen; or (*b*) that the question of the relation of post-cranial to cranial fragments in the deposits in which the South African australopithecine fossils have been found is as simply settled as he would have us believe. All that need be said about the belief that *SK*.49 possessed a low sagittal crest anterior to its bregma, but none in the region of the lambda, is that if this condition is regarded as characteristic of all *Paranthropus* skulls, the temporal muscles in this beast must have developed somewhat differently from the way they do in the great apes, and that the condition presumably corresponds to those unusual cases in the gibbon when the temporal lines meet each other, and fuse, just behind the bregma, to form such a crest.

S. Zuckerman

Department of Anatomy,
University of Birmingham.

[1] Robinson, J. T., *Nature*, **174**, 262 (1954).
[2] Zuckerman, S., chapter in "Evolution as a Process", 300 (Allen and Unwin, London, 1954).
[3] Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, No. 6 (Pretoria, 1952).
[4] Zuckerman, S., *Nature*, **174**, 264 (1954).

FORTHCOMING EVENTS

Wednesday, December 29

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion Meeting on "Education and Training of Radio Engineers".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m. —Discussion on "Gaps in the Knowledge of Applied Mechanics".

Wednesday, December 29—Monday, January 3

38TH CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College, Gower Street, London, W.C.1).

Wednesday, December 29

At 5 p.m. (in the Friends' Meeting House, Euston Road, London, N.W.1)—Sir Charles R. Morris: "Education and the Family" (Presidential Address).

Friday, December 31

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. S. Turnbull: "Lost-wax Process of Precision Casting, 1949–1953".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY TECHNICIAN (with experience of food and toxicological analysis) in the University of Edinburgh Department of Veterinary Hygiene and Preventive Medicine—The Secretary to the University, Old College, South Bridge, Edinburgh (January 1).

RESEARCH ASSISTANT (with a good honours degree in physics and experience in the design of electronic circuits, and preferably practical acquaintance with television or sound-film recording techniques) IN THE DEPARTMENT OF PHYSICS AND MATHEMATICS, to take part in the development of an electronic aid for the blind, and to undertake a certain amount of teaching—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (January 1).

RESEARCH ASSISTANT IN THE DEPARTMENT OF GEOLOGY—Clerk to the Governors, Chelsea Polytechnic, London, S.W.3 (January 10).

PHYSICIST AND PHYSICAL CHEMIST (with at least H.S.C. (science) or equivalent), at the Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to undertake laboratory studies of the basic structure and physical properties of plastics, rubbers and fibres, and to assist in applying these materials to Service projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.843/54A (January 14).

LECTURER (graduate in chemical engineering or graduate in chemistry with postgraduate training and/or experience in chemical engineering) IN CHEMICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (January 17).

LECTURER/SENIOR LECTURER IN BOTANY, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, January 19).

CHAIR OF AGRICULTURE tenable at Wye College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 27).

READER IN ARCHÆOLOGY OF THE ROMAN PROVINCES, at the Institute of Archæology—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 31).

RESEARCH SCHOLAR IN THE DEPARTMENT OF CHEMISTRY, for work on problems connected with aluminates—The Secretary, The University, Aberdeen (January 31).

HENRY AND CHARLOTTE PAYNE RESEARCH FELLOWSHIP in cytology and/or cyto-chemistry, with special reference to malignant cells—The Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W.1 (February 1).

LECTURER (graduate in science or agricultural science) IN BOTANY, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 1).

PROFESSOR OF PHYSICS in the Newcastle Division of the University of Durham, and a PROFESSOR OF PHYSICS in the Durham Colleges in the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (February 12).

CHAIR OF PHYSICS—The Registrar, The University, Hull (February 28).

AGRICULTURAL EDUCATION OFFICER (with a degree in agriculture and experience in teaching) in Basutoland, to take administrative and academic charge of a new training centre for subordinate staff of the Agricultural Department—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD 63/76/07.

ASSISTANT EXPERIMENTAL OFFICERS in the Department of Scientific and Industrial Research, Headquarters, Intelligence Division, for abstracting and technical information work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/54A.

ASSISTANT PROFESSOR (with a special interest in low temperature research) IN THE DEPARTMENT OF PHYSICS—Prof. W. H. Watson, University of Toronto, Toronto, Canada.

LECTURER OR ASSISTANT PROFESSOR IN MATHEMATICS—The Chairman, Department of Mathematics, McMaster University, Hamilton, Ontario, Canada.

MELVILLE WILLS CHAIR OF BOTANY—The Registrar, The University, Bristol 8.

PHYSICIST, Scientific Officer grade (with an interest in physics of the solid state, and preferably electronics experience) IN THE RADIO DIVISION, Royal Aircraft Establishment, Farnborough, Hants, to study the application of titanate ceramics and similar materials to radio frequency problems; and an ELECTRICAL ENGINEER or PHYSICIST, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree or equivalent, and for the senior grade at least three years postgraduate research experience), for research on special radio transmitting systems, in particular concerned with microwave region and with studies of modulation characteristics and frequency spectra—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.353/54A.

PHYSICIST, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree in physics, and preferably with some experience of methods of fast neutron flux measurement, and an interest in the development of fast neutron counters), for experimental work in neutron physics—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 322/WGE/2.

PHYSICIST (with a good honours degree), for work concerned with the physical principles (excluding electronics) and incidental problems associated with the development and manufacture of scientific instruments—The Director, British Scientific Instrument Research Association, "Sira", Southill, Elmstead Woods, Chislehurst, Kent.

PHYSICISTS or PHYSICAL CHEMISTS (with a good honours degree, and preferably with some research experience), for work which will involve both fundamental and applied research on textile fibres and related materials—Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

RESEARCH ASSISTANT (with a degree in physics or chemistry) IN THE DEPARTMENT OF COLLOID SCIENCE, to develop and maintain techniques applied to the investigation of macromolecules in solution (for example, sedimentation, diffusion, light scattering, etc.)—Dr. P. Johnson, Department of Colloid Science, The University, Cambridge.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in naval architecture, or alternatively in physics or mathematics with an interest in fluid dynamics), at the National Physical Laboratory, Teddington, for general research in the Ship Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.826/54A.

SENIOR LECTURER IN MECHANICAL ENGINEERING, at the Technical College, Bradford—Director of Education, Town Hall, Bradford 1.

SENIOR LECTURER (with sound experience in teaching and research at a university or a comparable level) IN ANIMAL HUSBANDRY—The Registrar, Wye College (University of London), Ashford, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Housing and Local Government. Report of an Informal Working Party on the Treatment and Disposal of Sewage Sludge. Pp. iii+64. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [2510

Air Ministry: Meteorological Office. Meteorological Reports No. 15: Cumulus and Cumulonimbus Cloud Over Malaya. By R. Frost. Pp. ii+18. (M.O. 535j.) (London: H.M. Stationery Office, 1954.) 1*s.* net. [2510

Department of Scientific and Industrial Research. Memoirs of the Geological Survey, Scotland. The Economic Geology of the Fife Coalfields. Area 3: Markinch, Dysart and Leven. By J. Knox. Palæontology by Dr. F. W. Anderson. Pp. viii+135+5 plates. (London: H.M. Stationery Office, 1954.) 12*s.* 6*d.* net. [2510

Aero Research Technical Notes. Bulletin No. 141 (September, 1954): "Aerolite" 300 for Boat Building. Pp. 6. (Duxford: Aero Research Limited, 1954.) [2510

Society for the Promotion of Nature Reserves. Handbook, 1954. Pp. 64+8 plates. (London: Society for the Promotion of Nature Reserves, British Museum (Natural History), 1954.) 5*s.* [2510

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Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 5: Food, Chemistry and Nutrition. By Dr. Magnus Pyke. Pp. ii+20. (London: Royal Institute of Chemistry, 1954.) [2510

British Museum (Natural History). Expedition to South-West Arabia, 1937–38. Vol. 1, Nos. 20–24. No. 20: Coleoptera: Histeridae. By Dr. Giuseppe Müller. No. 21: Coleoptera: Malachiidae und Dasytidae. By W. Wittmer. No. 22: Coleoptera: Brenthidae. By J. de Muizon. No. 23: Coleoptera: Scydmaenidae. By Jean Lhoste. No. 24: Coleoptera: (Nitidulidae) Meligethes Stephens. By Alan M. Easton. Pp. 307–350+plates 15–17. (London: British Museum (Natural History), 1954.) 7*s*. 6*d*. [2510

British Universities Film Council. 6th Annual Reports, 1953–54. Pp. 11. List of Films Nos. 1–600. (B.U.F.C. Card Catalogue 1952–1954.) Pp. iii+25. (Edinburgh: Dr. C. B. Childs (Hon. Secretary), c/o The University 1954.) [2510

Institute of Personnel Management. Annual Report, 1953–54. Pp. 19. (London: Institute of Personnel Management, 1954.) [2510

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Boiler Design and Availability. By W. F. Simonson. Pp. 28. (Bulletin No. MC/255.) (London: Boiler Availability Committee, 1954.) [2910

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Bowaters Build a Mill in Tennessee. Pp. ii+48. (London: Bowater Paper Corporation, 1954.) [111

Parks for the Nation: a Survey of How the National Parks Act is Working. By Tom Stephenson. Pp. 12. (London: Ramblers' Association, 1954.) 6*d*. [211

Freshwater Biological Association. Scientific Publication No. 15: A Revised Key to the Adults of the British Species of Ephemeroptera, with notes on Their Ecology. By D. E. Kimmins. Pp. 71. 3*s*. Twenty-Second Annual Report for the year ended 31st March, 1954. Pp. 63+1 plate. 3*s*. (Ambleside: Freshwater Biological Association, 1954.) [211

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Kumamoto Journal of Science. Series A (Mathematics, Physics and Chemistry). Volume 1, No. 1 (October 1952). Pp. 84. (Kumamoto: Faculty of Science, Kumamoto University, 1952.) [2510

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